

US009049500B2

(12) **United States Patent**
Conner et al.

(10) **Patent No.:** **US 9,049,500 B2**
(45) **Date of Patent:** **Jun. 2, 2015**

(54) **FIBER OPTIC TERMINALS, SYSTEMS, AND METHODS FOR NETWORK SERVICE MANAGEMENT**

(75) Inventors: **Mark E. Conner**, Granite Falls, NC (US); **Kenneth F. Dunn, Jr.**, Statesville, NC (US)

(73) Assignee: **Corning Cable Systems LLC**, Hickory, NC (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 102 days.

(21) Appl. No.: **13/601,245**

(22) Filed: **Aug. 31, 2012**

(65) **Prior Publication Data**

US 2014/0064731 A1 Mar. 6, 2014

(51) **Int. Cl.**

H04J 14/00 (2006.01)

H04Q 11/00 (2006.01)

H04B 10/2575 (2013.01)

(52) **U.S. Cl.**

CPC **H04Q 11/0067** (2013.01); **H04B 10/25756** (2013.01)

(58) **Field of Classification Search**

CPC H04Q 11/0067; H04Q 11/0428; H04J 14/023; H04J 14/0239; H04J 14/0242; H04J 14/0245; H04J 14/0247; H04J 14/0252; H04B 10/25753; H04B 10/25754; H04B 10/25756; H04B 10/27; H04B 10/272; H04B 10/278

USPC 398/43-74, 33, 13, 20, 28, 2-7, 141, 398/142, 139, 134

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,280,393 A 10/1918 Cannon
1,703,255 A 2/1929 Wagner
2,003,147 A 5/1935 Holm-Hansen
2,044,073 A 6/1936 Hurley

(Continued)

FOREIGN PATENT DOCUMENTS

DE 4130706 A1 3/1993
DE 4133375 C1 4/1993

(Continued)

OTHER PUBLICATIONS

Mark M. Clougherty, et al., "The AnyMedia® Access System—Providing Solutions for Distribution and Network Independence," Bell Labs Technical Journal, vol. 4, Issue 2, 1999, pp. 98-127.

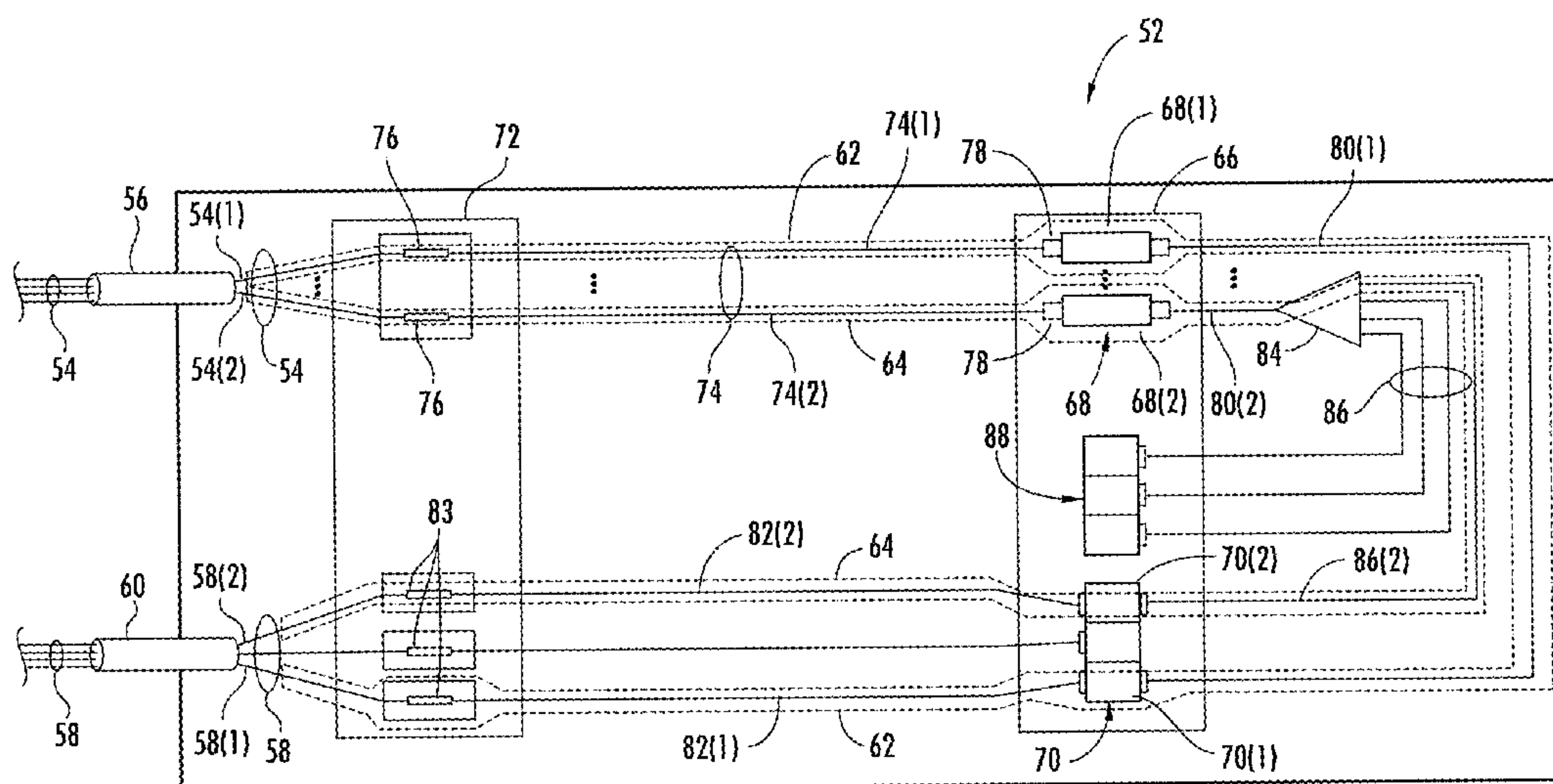
(Continued)

Primary Examiner — M. R. Sedighian

(57) **ABSTRACT**

Fiber optic terminals, systems, and methods for providing differentiated network services to subscribers of a fiber optic network are disclosed. In certain embodiments, fiber optic terminals and methods are disclosed for providing more than one network service to subscribers supported by the same fiber optic terminal. In one embodiment, a fiber optic terminal is provided comprising a first optical path connected to a first network-side optical fiber providing a first network service to a first subscriber-side optical fiber. The fiber optic terminal also comprises a second optical path connected to a second network-side optical fiber providing a second network service differentiated from the first network service to a second subscriber-side optical fiber. In this manner, differentiated network services can be provided to subscribers supported by the fiber optic terminal by configuring connections of the subscribers to either the first optical path or second optical path in the fiber optic terminal.

12 Claims, 7 Drawing Sheets



(56)

References Cited

U.S. PATENT DOCUMENTS

2,131,408 A	9/1938	Murrer	5,274,731 A	12/1993	White
2,428,149 A	9/1947	Falk	5,287,428 A	2/1994	Shibata
2,681,201 A	6/1954	Grunwald	5,317,663 A	5/1994	Beard et al.
2,984,488 A	5/1961	Kirchner	5,323,480 A	6/1994	Mullaney et al.
3,054,994 A	9/1962	Haram	5,333,221 A	7/1994	Briggs et al.
3,204,867 A	9/1965	Wahlbom	5,333,222 A	7/1994	Belenkiy et al.
3,435,124 A	3/1969	Channell	5,348,240 A	9/1994	Carmo et al.
3,880,390 A	4/1975	Niven	5,359,688 A	10/1994	Underwood
4,006,540 A	2/1977	Lemelson	5,363,465 A	11/1994	Korkowski et al.
4,012,010 A	3/1977	Friedman	5,367,598 A	11/1994	Devenish, III et al.
4,073,560 A	2/1978	Anhalt et al.	5,375,185 A	12/1994	Hermesen et al.
4,123,012 A	10/1978	Hough	5,383,051 A	1/1995	Delrosso et al.
4,177,961 A	12/1979	Gruenewald	5,402,515 A	3/1995	Vidacovich et al.
4,210,380 A	7/1980	Brzostek	5,408,557 A	4/1995	Hsu
D257,613 S	12/1980	Gruenewald	RE34,955 E	5/1995	Anton et al.
4,244,544 A	1/1981	Kornat	5,420,956 A	5/1995	Grugel et al.
4,261,529 A	4/1981	Sandberg et al.	5,420,958 A	5/1995	Henson et al.
4,261,644 A	4/1981	Giannaris	5,428,705 A	6/1995	Hermesen et al.
4,480,449 A	11/1984	Getz et al.	5,432,875 A	7/1995	Korkowski et al.
4,497,457 A	2/1985	Harvey	5,438,641 A	8/1995	Malacarne
4,502,754 A	3/1985	Kawa	5,442,726 A	8/1995	Howard et al.
4,506,698 A	3/1985	Garcia et al.	5,448,015 A	9/1995	Jamet et al.
4,524,384 A	6/1985	Lefkowitz et al.	5,460,342 A	10/1995	Dore et al.
D281,574 S	12/1985	O'Hara, II	5,473,115 A	12/1995	Brownlie et al.
4,579,310 A	4/1986	Wells et al.	5,479,553 A	12/1995	Daems et al.
4,586,675 A	5/1986	Brown	5,479,554 A	12/1995	Roberts
4,595,255 A	6/1986	Bhatt et al.	5,490,229 A	2/1996	Ghandeharizadeh et al.
4,611,887 A	9/1986	Glover et al.	5,497,444 A	3/1996	Wheeler
4,697,873 A	10/1987	Bouvard et al.	5,515,472 A	5/1996	Mullaney et al.
4,736,100 A	4/1988	Vastagh	5,542,015 A	7/1996	Hultermans
4,747,020 A	5/1988	Brickley et al.	5,548,678 A	8/1996	Frost et al.
4,778,125 A	10/1988	Hu	5,553,183 A	9/1996	Bechamps
4,806,814 A	2/1989	Nold	5,553,186 A	9/1996	Allen
4,810,054 A	3/1989	Shinbori et al.	5,556,060 A	9/1996	Bingham et al.
4,812,004 A	3/1989	Biederstedt et al.	5,559,922 A	9/1996	Arnett
4,824,193 A	4/1989	Maeda et al.	5,570,895 A	11/1996	McCue et al.
4,836,479 A	6/1989	Adams	5,579,425 A	11/1996	Lampert et al.
4,844,573 A	7/1989	Gillham et al.	5,590,234 A	12/1996	Pulido
4,884,863 A	12/1989	Throckmorton	5,607,126 A	3/1997	Cordola et al.
4,900,118 A	2/1990	Yanagawa et al.	5,613,030 A	3/1997	Hoffer et al.
4,900,123 A	2/1990	Barlow et al.	5,617,501 A	4/1997	Miller et al.
4,948,220 A	8/1990	Violo et al.	5,627,925 A	5/1997	Alferness et al.
4,961,623 A	10/1990	Midkiff et al.	5,647,043 A	7/1997	Anderson et al.
4,979,749 A	12/1990	Onanian	5,649,042 A	7/1997	Saito
4,995,688 A	2/1991	Anton et al.	5,652,814 A	7/1997	Pan et al.
5,007,701 A	4/1991	Roberts	5,659,655 A	8/1997	Pilatos
5,023,646 A	6/1991	Ishida et al.	5,689,605 A	11/1997	Cobb et al.
5,048,916 A	9/1991	Caron	5,689,607 A	11/1997	Vincent et al.
5,048,926 A	9/1991	Tanimoto	5,692,299 A	12/1997	Daems et al.
5,066,149 A	11/1991	Wheeler et al.	5,694,511 A	12/1997	Pimpinella et al.
5,071,211 A	12/1991	Debortoli et al.	5,706,384 A	1/1998	Peacock et al.
5,071,220 A	12/1991	Ruello et al.	5,708,751 A	1/1998	Mattei
5,073,042 A	12/1991	Mulholland et al.	5,717,810 A	2/1998	Wheeler
5,074,635 A	12/1991	Justice et al.	5,724,469 A	3/1998	Orlando
5,076,688 A	12/1991	Bowen et al.	5,731,546 A	3/1998	Miles et al.
5,085,384 A	2/1992	Kasubke	5,734,776 A	3/1998	Puetz
5,112,014 A	5/1992	Nichols	5,737,475 A	4/1998	Register
D327,312 S	6/1992	Myojo	5,751,882 A	5/1998	Daems et al.
5,121,458 A	6/1992	Nilsson et al.	5,758,004 A	5/1998	Alarcon et al.
5,142,598 A	8/1992	Tabone	5,764,843 A	6/1998	Macken et al.
D330,368 S	10/1992	Bourgeois et al.	5,774,612 A	6/1998	Belenkiy et al.
5,189,410 A	2/1993	Kosugi et al.	5,775,648 A	7/1998	Metzger
5,204,929 A	4/1993	Machall et al.	5,778,132 A	7/1998	Csipkes et al.
5,209,441 A	5/1993	Satoh	5,781,678 A	7/1998	Sano et al.
5,210,374 A	5/1993	Channell	5,793,920 A	8/1998	Wilkins et al.
5,214,735 A	5/1993	Henneberger et al.	5,793,921 A	8/1998	Wilkins et al.
5,218,664 A	6/1993	O'Neill et al.	5,796,908 A	8/1998	Vicory
5,231,687 A	7/1993	Handley	5,802,237 A	9/1998	Pulido
5,233,674 A	8/1993	Vladic	5,810,461 A	9/1998	Ive et al.
5,243,679 A	9/1993	Sharrow et al.	5,816,081 A	10/1998	Johnston
5,255,161 A	10/1993	Knoll et al.	5,823,646 A	10/1998	Arizpe et al.
5,260,957 A	11/1993	Hakimi et al.	5,825,955 A	10/1998	Ernst et al.
5,261,020 A	11/1993	de Jong et al.	5,825,961 A	10/1998	Wilkins et al.
5,265,187 A	11/1993	Morin et al.	5,832,162 A	11/1998	Sarbell
5,271,585 A	12/1993	Zetena, Jr.	5,835,657 A	11/1998	Suarez et al.
			5,835,658 A	11/1998	Smith
			5,862,290 A	1/1999	Burek et al.
			5,867,621 A	2/1999	Luther et al.
			5,870,519 A	2/1999	Jenkins et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

5,880,864	A	3/1999	Williams et al. 359/124	6,434,316	B1	8/2002	Grois et al.
5,881,200	A	3/1999	Burt	6,438,310	B1	8/2002	Lance et al.
5,883,995	A	3/1999	Lu	6,439,780	B1	8/2002	Mudd et al.
5,884,003	A	3/1999	Cloud et al.	D463,253	S	9/2002	Canty
5,892,877	A	4/1999	Meyerhoefer	6,452,925	B1	9/2002	Sistanizadeh et al.
5,909,526	A	6/1999	Roth et al.	6,456,772	B1	9/2002	Daoud
5,930,425	A	7/1999	Abel et al.	6,464,402	B1	10/2002	Andrews et al.
5,945,633	A	8/1999	Ott et al.	D466,087	S	11/2002	Cuny et al.
5,946,440	A	8/1999	Puetz	6,480,487	B1	11/2002	Wegleitner et al.
5,956,439	A	9/1999	Pimpinella	6,480,660	B1	11/2002	Reitmeier et al.
5,956,444	A	9/1999	Duda et al.	6,483,977	B2	11/2002	Battey et al.
5,969,294	A	10/1999	Eberle et al.	6,484,991	B2	11/2002	Sher
5,975,769	A	11/1999	Larson et al.	6,496,640	B1	12/2002	Harvey et al.
5,978,540	A	11/1999	Bechamps et al.	6,499,608	B1	12/2002	Sterling et al.
6,009,225	A	12/1999	Ray et al.	D468,996	S	1/2003	Sarkinen et al.
6,027,252	A	2/2000	Erdman et al.	6,507,691	B1	1/2003	Hunsinger et al.
6,044,193	A	3/2000	Szentesi et al.	6,522,814	B2	2/2003	Yoshida et al.
6,059,215	A	5/2000	Finnis	6,532,332	B2	3/2003	Solheid et al.
6,061,492	A	5/2000	Strause et al.	6,535,682	B1	3/2003	Puetz et al.
6,065,968	A	5/2000	Corliss	6,539,155	B1	3/2003	Broeng et al.
6,079,881	A	6/2000	Roth	6,539,160	B2	3/2003	Battey et al.
D427,897	S	7/2000	Johnston et al.	6,542,652	B1	4/2003	Mahony
6,118,075	A	9/2000	Baker et al.	6,542,688	B1	4/2003	Battey et al.
6,129,221	A	10/2000	Shaha	6,543,100	B1	4/2003	Finley et al.
6,149,315	A	11/2000	Stephenson	6,554,485	B1	4/2003	Beatty et al.
6,151,436	A	11/2000	Burek et al.	6,556,738	B2	4/2003	Pfeiffer et al.
6,160,946	A	12/2000	Thompson et al.	6,556,763	B1	4/2003	Puetz et al.
D436,027	S	1/2001	Johnston et al.	6,567,601	B2	5/2003	Daoud et al.
6,175,079	B1	1/2001	Johnston et al.	6,571,047	B1	5/2003	Yarkosky et al.
6,188,687	B1	2/2001	Mussman et al.	6,577,595	B1	6/2003	Counterman
6,188,825	B1	2/2001	Bandy et al.	6,577,801	B2	6/2003	Broderick et al.
6,192,180	B1	2/2001	Kim et al.	6,579,014	B2	6/2003	Melton et al.
6,208,796	B1	3/2001	Williams Vigliaturo	6,580,867	B2	6/2003	Galaj et al.
6,215,938	B1	4/2001	Reitmeier et al.	6,581,788	B1	6/2003	Winig et al.
6,226,111	B1	5/2001	Chang et al.	6,591,051	B2	7/2003	Solheid et al.
6,227,717	B1	5/2001	Ott et al.	6,594,434	B1	7/2003	Davidson et al.
6,234,683	B1	5/2001	Waldron et al.	6,597,670	B1	7/2003	Tweedy et al.
6,236,795	B1	5/2001	Rodgers	6,598,949	B2	7/2003	Frazier et al.
6,240,229	B1	5/2001	Roth	6,612,515	B1	9/2003	Tinucci et al.
6,243,526	B1	6/2001	Garibay et al.	6,614,953	B2	9/2003	Strasser et al.
6,245,998	B1	6/2001	Curry et al.	6,614,974	B2	9/2003	Elrefaie et al.
6,259,851	B1	7/2001	Daoud	6,614,980	B1	9/2003	Mahony
6,263,136	B1	7/2001	Jennings et al.	6,621,952	B1	9/2003	Pi et al.
6,263,141	B1	7/2001	Smith	6,621,975	B2	9/2003	Laporte et al.
6,269,212	B1	7/2001	Schiattone	6,625,374	B2	9/2003	Holman et al.
6,275,640	B1	8/2001	Hunsinger et al.	6,625,375	B1	9/2003	Mahony
6,275,641	B1	8/2001	Daoud	6,631,237	B2	10/2003	Knudsen et al.
6,278,829	B1	8/2001	BuAbbud et al.	6,633,717	B1	10/2003	Knight et al.
6,278,831	B1	8/2001	Henderson et al.	6,640,028	B1	10/2003	Schroll et al.
6,289,159	B1	9/2001	Van Hees et al.	RE38,311	E	11/2003	Wheeler
6,292,614	B1	9/2001	Smith et al.	6,652,163	B2	11/2003	Fajardo et al.
6,304,707	B1	10/2001	Daems et al.	6,654,536	B2	11/2003	Battey et al.
6,307,997	B1	10/2001	Walters et al.	6,668,127	B1	12/2003	Mahony
6,307,998	B2	10/2001	Williams Vigliaturo	6,674,952	B2	1/2004	Howell et al.
6,311,007	B1	10/2001	Daoud	6,710,366	B1	3/2004	Lee et al.
RE37,489	E	1/2002	Anton et al.	6,711,339	B2	3/2004	Puetz et al.
6,343,313	B1	1/2002	Salesky et al.	6,715,619	B2	4/2004	Kim et al.
6,347,888	B1	2/2002	Puetz	6,741,784	B1	5/2004	Guan
6,351,592	B1	2/2002	Ehn et al.	D491,286	S	6/2004	Winig et al.
6,353,696	B1	3/2002	Gordon et al.	D491,287	S	6/2004	Winig et al.
6,353,697	B1	3/2002	Daoud	D491,449	S	6/2004	Winig et al.
6,359,228	B1	3/2002	Strause et al.	6,748,155	B2	6/2004	Kim et al.
6,363,183	B1	3/2002	Koh	6,760,531	B1	7/2004	Solheid et al.
6,363,200	B1	3/2002	Thompson et al.	6,766,094	B2	7/2004	Smith et al.
6,370,294	B1	4/2002	Pfeiffer et al.	D495,067	S	8/2004	Winig et al.
6,385,381	B1	5/2002	Janus et al.	6,778,752	B2	8/2004	Laporte et al.
6,397,166	B1	5/2002	Leung et al.	6,792,191	B1	9/2004	Clapp, Jr. et al.
6,411,767	B1	6/2002	Burrous et al.	6,795,633	B2	9/2004	Joseph, II
6,418,262	B1	7/2002	Puetz et al.	6,801,695	B2	10/2004	Lanier et al.
6,424,781	B1	7/2002	Puetz et al.	6,802,724	B1	10/2004	Mahony
6,424,782	B1	7/2002	Ray	6,804,447	B2	10/2004	Smith et al.
6,425,694	B1	7/2002	Szilagyi et al.	6,809,258	B1	10/2004	Dang et al.
6,427,035	B1	7/2002	Mahony	D498,005	S	11/2004	Winig et al.
6,431,762	B1	8/2002	Taira et al.	6,816,661	B1	11/2004	Barnes et al.
6,434,313	B1	8/2002	Clapp, Jr. et al.	6,819,856	B2	11/2004	Dagley et al.
				6,819,857	B2	11/2004	Douglas et al.
				6,845,207	B2	1/2005	Schray et al.
				6,850,685	B2	2/2005	Tinucci et al.
				6,865,334	B2	3/2005	Cooke et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

6,870,734 B2	3/2005	Mertesdorf et al.	7,766,732 B2	8/2010	Hauville
6,870,997 B2	3/2005	Cooke et al.	7,769,265 B2	8/2010	Cairns
6,879,545 B2	4/2005	Cooke et al.	7,822,310 B2	10/2010	Castonguay et al.
6,880,982 B2	4/2005	Imamura	7,844,161 B2	11/2010	Reagan et al.
6,885,798 B2	4/2005	Zimmel	7,889,961 B2	2/2011	Cote et al.
6,915,058 B2	7/2005	Pons	7,970,249 B2	6/2011	Solheid et al.
6,915,059 B2	7/2005	Daoud et al.	7,974,509 B2	7/2011	Smith et al.
6,920,273 B2	7/2005	Knudsen	8,086,085 B2	12/2011	Lu et al.
6,920,274 B2	7/2005	Rapp et al.	8,265,447 B2	9/2012	Loeffelholz et al.
6,925,241 B2	8/2005	Bohle et al.	8,351,754 B2	1/2013	Bell
6,925,852 B2	8/2005	Susko	8,380,036 B2	2/2013	Smith
6,932,514 B2	8/2005	Anderson et al.	8,437,595 B2	5/2013	Womack et al.
6,934,451 B2	8/2005	Cooke et al.	8,465,317 B2	6/2013	Gniadek et al.
6,937,807 B2	8/2005	Franklin et al.	8,467,651 B2	6/2013	Cao et al.
6,946,605 B2	9/2005	Levesque et al.	8,660,397 B2	2/2014	Giraud et al.
6,968,107 B2	11/2005	Belardi et al.	8,712,206 B2	4/2014	Cooke et al.
6,983,095 B2	1/2006	Reagan et al.	2001/0001270 A1	5/2001	Williams Vigliaturo
6,986,608 B2	1/2006	Choudhury et al.	2001/0036351 A1	11/2001	Fritz
6,993,228 B2	1/2006	Burke, Jr. et al.	2002/0034290 A1	3/2002	Pershan
7,006,748 B2	2/2006	Dagley et al.	2002/0037136 A1	3/2002	Wang et al.
7,027,695 B2	4/2006	Cooke et al.	2002/0051616 A1	5/2002	Batthey et al.
7,054,513 B2	5/2006	Herz et al.	2002/0118929 A1	8/2002	Brun et al.
7,068,907 B2	6/2006	Schray	2002/0148846 A1	10/2002	Luburic
7,083,051 B2	8/2006	Smith et al.	2002/0150372 A1	10/2002	Schray
7,088,891 B2	8/2006	Jung et al.	2002/0180163 A1	12/2002	Muller et al.
7,110,654 B2	9/2006	Dillat	2002/0181896 A1	12/2002	McClellan et al.
7,120,347 B2	10/2006	Blackwell, Jr. et al.	2002/0181905 A1	12/2002	Yoshida et al.
7,128,470 B2	10/2006	Scherer et al.	2003/0031419 A1	2/2003	Simmons et al.
7,130,519 B2	10/2006	Grubish et al.	2003/0063866 A1	4/2003	Melton et al.
7,142,763 B2	11/2006	Frohlich et al.	2003/0063875 A1	4/2003	Bickham et al.
7,142,764 B2	11/2006	Allen et al.	2003/0095774 A1	5/2003	Bohme et al.
7,155,106 B2	12/2006	Cianciotto et al.	2003/0103750 A1	6/2003	Laporte et al.
7,171,121 B1	1/2007	Skarica et al.	2003/0132685 A1	7/2003	Sucharczuk et al.
7,181,142 B1	2/2007	Xu et al.	2003/0134541 A1	7/2003	Johnsen et al.
7,200,316 B2	4/2007	Giraud et al.	2003/0142946 A1	7/2003	Saito et al.
7,200,317 B2	4/2007	Reagan et al.	2003/0147597 A1	8/2003	Duran
7,201,595 B1	4/2007	Morello	2003/0174996 A1	9/2003	Henschel et al.
7,215,865 B2	5/2007	Bellekens et al.	2003/0185535 A1	10/2003	Tinucci et al.
7,218,828 B2	5/2007	Feustel et al.	2003/0194187 A1	10/2003	Simmons et al.
7,245,811 B2	7/2007	Takeda et al.	2003/0223725 A1	12/2003	Laporte et al.
7,260,302 B2	8/2007	Caveney	2004/0001686 A1	1/2004	Smith et al.
7,264,402 B2	9/2007	Theuerkorn et al.	2004/0013390 A1	1/2004	Kim et al.
7,266,283 B2	9/2007	Kline et al.	2004/0042710 A1	3/2004	Margalit et al.
7,272,291 B2	9/2007	Bayazit et al.	2004/0074852 A1	4/2004	Knudsen et al.
7,274,852 B1	9/2007	Smrha et al.	2004/0081404 A1	4/2004	Elliott
7,280,733 B2	10/2007	Larson et al.	2004/0084465 A1	5/2004	Luburic
7,289,731 B2	10/2007	Thinguldstad	2004/0109660 A1	6/2004	Liberty
7,298,951 B2	11/2007	Smrha et al.	2004/0123998 A1	7/2004	Berglund et al.
7,302,153 B2	11/2007	Thom	2004/0141692 A1	7/2004	Anderson et al.
7,310,471 B2	12/2007	Bayazit et al.	2004/0146266 A1	7/2004	Solheid et al.
7,330,629 B2	2/2008	Cooke et al.	2004/0150267 A1	8/2004	Ferguson
7,331,722 B2	2/2008	Tan	2004/0175090 A1	9/2004	Vastmans et al.
7,349,616 B1	3/2008	Castonguay et al.	2004/0218970 A1	11/2004	Caveney et al.
7,369,741 B2	5/2008	Reagan et al.	2004/0228598 A1	11/2004	Allen et al.
7,376,325 B1	5/2008	Cloud et al.	2004/0240825 A1	12/2004	Daoud et al.
7,379,650 B2	5/2008	Weinert et al.	2004/0264873 A1	12/2004	Smith et al.
7,406,241 B1	7/2008	Opaluch et al.	2005/0002633 A1	1/2005	Solheid et al.
7,412,145 B2	8/2008	Honma et al.	2005/0036749 A1	2/2005	Vogel et al.
7,418,182 B2	8/2008	Krampotich	2005/0100301 A1	5/2005	Solheid et al.
7,418,184 B1	8/2008	Gonzales et al.	2005/0123261 A1	6/2005	Bellekens et al.
7,421,182 B2	9/2008	Bayazit et al.	2005/0129379 A1	6/2005	Reagan et al.
7,450,806 B2	11/2008	Bookbinder et al.	2005/0135753 A1	6/2005	Eigenmann et al.
7,460,757 B2	12/2008	Hoehne et al.	2005/0152306 A1	7/2005	Bonnassieux et al.
7,471,867 B2	12/2008	Vogel et al.	2005/0213921 A1	9/2005	Mertesdorf et al.
7,477,826 B2	1/2009	Mullaney et al.	2005/0232565 A1	10/2005	Heggestad et al.
7,496,269 B1	2/2009	Lee	2005/0238290 A1	10/2005	Choudhury et al.
7,509,016 B2	3/2009	Smith et al.	2005/0265683 A1	12/2005	Cianciotto et al.
7,522,805 B2	4/2009	Smith et al.	2005/0276562 A1	12/2005	Batthey et al.
7,526,174 B2	4/2009	Leon et al.	2005/0281526 A1	12/2005	Vongseng et al.
7,609,967 B2	10/2009	Hochbaum et al.	2006/0029334 A1	2/2006	Quinby et al.
7,613,376 B2	11/2009	Wright et al.	2006/0049941 A1	3/2006	Hunter et al.
7,623,749 B2	11/2009	Reagan et al.	2006/0072892 A1	4/2006	Serrander et al.
7,636,507 B2	12/2009	Lu et al.	2006/0083461 A1	4/2006	Takahashi et al.
7,664,361 B2	2/2010	Trebesch et al.	2006/0083468 A1	4/2006	Kahle et al.
7,690,848 B2	4/2010	Faika et al.	2006/0093278 A1	5/2006	Elkins, II et al.
			2006/0093301 A1	5/2006	Zimmel et al.
			2006/0093303 A1	5/2006	Reagan et al.
			2006/0098931 A1	5/2006	Sibley et al.
			2006/0127087 A1*	6/2006	Kasai et al. 398/45

(56)

References Cited

FOREIGN PATENT DOCUMENTS

U.S. PATENT DOCUMENTS

2006/0133753 A1 6/2006 Nelson et al.
 2006/0153515 A1 7/2006 Honma et al.
 2006/0153516 A1 7/2006 Napiorkowski et al.
 2006/0153517 A1 7/2006 Reagan et al.
 2006/0165364 A1 7/2006 Frohlich et al.
 2006/0182407 A1 8/2006 Caveney
 2006/0193590 A1 8/2006 Puetz et al.
 2006/0210229 A1 9/2006 Scadden
 2006/0210230 A1 9/2006 Kline et al.
 2006/0215980 A1 9/2006 Bayazit et al.
 2006/0251373 A1 11/2006 Hodge et al.
 2006/0263029 A1 11/2006 Mudd et al.
 2006/0269205 A1 11/2006 Zimmel
 2006/0269206 A1 11/2006 Zimmel
 2006/0269208 A1 11/2006 Allen et al.
 2006/0275007 A1 12/2006 Livingston et al.
 2006/0275008 A1 12/2006 Xin
 2006/0279423 A1 12/2006 Nazari
 2006/0285807 A1 12/2006 Lu et al.
 2007/0003204 A1 1/2007 Makrides-Saravanos et al.
 2007/0003205 A1 1/2007 Saravanos et al.
 2007/0023464 A1 2/2007 Barkdoll et al.
 2007/0031099 A1 2/2007 Herzog et al.
 2007/0031101 A1 2/2007 Kline et al.
 2007/0047891 A1 3/2007 Bayazit et al.
 2007/0047893 A1 3/2007 Kramer et al.
 2007/0047894 A1 3/2007 Holmberg et al.
 2007/0052531 A1 3/2007 Mathews et al.
 2007/0104447 A1 5/2007 Allen
 2007/0114339 A1 5/2007 Winchester
 2007/0183732 A1 8/2007 Wittmeier et al.
 2007/0263962 A1 11/2007 Kohda
 2007/0274718 A1 11/2007 Bridges et al.
 2008/0008437 A1 1/2008 Reagan et al.
 2008/0063350 A1 3/2008 Trebesch et al.
 2008/0085094 A1 4/2008 Krampotich
 2008/0131067 A1 6/2008 Ugolini et al.
 2008/0138026 A1 6/2008 Yow et al.
 2008/0145008 A1 6/2008 Lewallen et al.
 2008/0193091 A1 8/2008 Herbst
 2008/0205844 A1 8/2008 Castonguay et al.
 2008/0253723 A1 10/2008 Stokes et al.
 2008/0259928 A1 10/2008 Chen et al.
 2008/0292261 A1 11/2008 Kowalczyk et al.
 2008/0317425 A1 12/2008 Smith et al.
 2009/0022470 A1 1/2009 Krampotich
 2009/0034929 A1 2/2009 Reinhardt et al.
 2009/0060440 A1 3/2009 Wright et al.
 2009/0074371 A1 3/2009 Bayazit et al.
 2009/0097813 A1 4/2009 Hill
 2009/0103865 A1 4/2009 Del Rosso
 2009/0103878 A1 4/2009 Zimmel
 2009/0148118 A1 6/2009 Gronvall et al.
 2009/0208210 A1 8/2009 Trojer et al.
 2009/0245743 A1 10/2009 Cote et al.
 2009/0245746 A1 10/2009 Krampotich et al.
 2009/0252462 A1 10/2009 Bonical
 2009/0263122 A1 10/2009 Helkey et al.
 2009/0274429 A1 11/2009 Krampotich et al.
 2009/0297111 A1 12/2009 Reagan et al.
 2009/0304342 A1 12/2009 Adomeit et al.
 2009/0324189 A1 12/2009 Hill et al.
 2010/0061693 A1 3/2010 Bran De Leon et al.
 2010/0183274 A1 7/2010 Brunet et al.
 2010/0290753 A1 11/2010 Tang et al.
 2011/0052133 A1 3/2011 Simmons et al.
 2011/0097052 A1 4/2011 Solheid et al.
 2011/0158599 A1 6/2011 Kowalczyk et al.
 2012/0104145 A1 5/2012 Dagley et al.
 2012/0301096 A1 11/2012 Badar et al.
 2012/0308190 A1 12/2012 Smith et al.
 2013/0034333 A1 2/2013 Holmberg et al.
 2014/0119705 A1 5/2014 Fabrykowski et al.

DE 4240727 C1 2/1994
 DE 29800194 U1 3/1998
 DE 10005294 A1 8/2001
 DE 10238189 A1 2/2004
 DE 202004011493 U1 9/2004
 DE 20320702 U1 10/2005
 DE 202005018884 U1 2/2006
 DE 202007000556 U1 10/2007
 DE 202007012420 U1 10/2007
 DE 202010009385 U1 9/2010
 EP 0409390 A2 1/1991
 EP 0410622 A2 1/1991
 EP 0415647 A2 3/1991
 EP 0490644 A1 6/1992
 EP 0541820 A1 5/1993
 EP 0593927 A1 4/1994
 EP 0720322 A2 7/1996
 EP 0725468 A1 8/1996
 EP 0828356 A2 3/1998
 EP 0840153 A2 5/1998
 EP 0928053 A2 7/1999
 EP 1107031 A1 6/2001
 EP 1120674 A1 8/2001
 EP 1179745 A2 2/2002
 EP 1203974 A2 5/2002
 EP 1316829 A2 6/2003
 EP 1944635 A2 7/2008
 EP 1944886 A1 7/2008
 EP 2060942 A2 5/2009
 EP 2141527 A2 1/2010
 FR 2123728 A5 9/1972
 FR 2748576 A1 11/1997
 GB 2254163 A 9/1992
 JP 59107317 A 6/1984
 JP 6227312 A 8/1994
 JP 11125722 A 5/1999
 JP 11231163 A 8/1999
 JP 2001116968 A 4/2001
 JP 2004061713 A 2/2004
 WO 8805925 A1 8/1988
 WO 8905989 A1 6/1989
 WO 9507484 A1 3/1995
 WO 9630791 A1 10/1996
 WO 9638752 A1 12/1996
 WO 9722025 A1 6/1997
 WO 9725642 A1 7/1997
 WO 9736197 A1 10/1997
 WO 0221186 A1 3/2002
 WO 02099528 A1 12/2002
 WO 03009527 A2 1/2003
 WO WO03/009527 A2 1/2003 H04L 12/00
 WO 03093889 A1 11/2003
 WO 2004086112 A1 10/2004
 WO 2005020400 A1 3/2005
 WO 2005050277 A2 6/2005
 WO 2005088373 A1 9/2005
 WO 2005091036 A1 9/2005
 WO 2006050505 A1 5/2006
 WO 2006127457 A1 11/2006
 WO 2006135524 A3 12/2006
 WO 2007050515 A1 5/2007
 WO 2007089682 A2 8/2007
 WO 2007129953 A1 11/2007
 WO 2008033997 A1 3/2008
 WO 2008048935 A2 4/2008
 WO 2008125217 A1 10/2008
 WO 2008137894 A1 11/2008
 WO 2009029485 A1 3/2009

OTHER PUBLICATIONS

Kikuchi, et al., "Optical wavelength-division multiplexing high-speed switching system for B-ISDN," Proceedings of the Global Telecommunications Conference, New York, IEEE, Dec. 1991, 5 pages.
 Patent Cooperation Treaty, International Search Report for International Application No. PCT/US2009/066779, Aug. 27, 2010, 2 pages.

(56)

References Cited

OTHER PUBLICATIONS

Non-final Office Action for U.S. Appl. No. 12/417,250 mailed Jun. 23, 2011, 9 pages.
 Final Office Action for U.S. Appl. No. 12/417,250 mailed Mar. 3, 2011, 9 pages.
 Non-final Office Action for U.S. Appl. No. 12/417,250 mailed Jul. 27, 2010, 11 pages.
 Advisory Action for U.S. Appl. No. 12/697,628 mailed Mar. 1, 2012, 3 pages.
 Final Office Action for U.S. Appl. No. 12/697,628 mailed Nov. 17, 2011, 15 pages.
 Non-final Office Action for U.S. Appl. No. 12/697,628 mailed Apr. 6, 2011, 11 pages.
 Final Office Action for U.S. Appl. No. 12/630,938 mailed Jun. 1, 2012, 18 pages.
 Non-final Office Action for U.S. Appl. No. 12/630,938 mailed Dec. 19, 2011, 15 pages.
 Quayle Action for U.S. Appl. No. 12/861,345 mailed Apr. 9, 2012, 6 pages.
 Non-final Office Action for U.S. Appl. No. 12/861,345 mailed Dec. 15, 2011, 10 pages.
 Non-final Office Action for U.S. Appl. No. 12/700,837 mailed Jan. 30, 2012, 7 pages.
 Final Office Action for U.S. Appl. No. 12/474,866 mailed Jan. 31, 2012, 8 pages.
 Non-final Office Action for U.S. Appl. No. 12/474,866 mailed Aug. 5, 2011, 9 pages.
 International Search Report for PCT/US2009/066779, Aug. 27, 2010, 3 pages.
 International Search Report for PCT/EP2009/000929, Apr. 27, 2009, 4 pages.
 Final Office Action for U.S. Appl. No. 12/700,837 mailed Aug. 31, 2012, 10 pages.
 International Search Report for PCT/US2007/023631, mailed Apr. 21, 2008, 2 pages.
 International Search Report for PCT/US2008/000095 mailed Sep. 12, 2008, 5 pages.
 International Search Report for PCT/US2008/002514 mailed Aug. 8, 2008, 2 pages.
 International Search Report for PCT/US2008/006798 mailed Oct. 1, 2008, 2 pages.
 Advisory Action for U.S. Appl. No. 12/072,187 mailed Aug. 15, 2011, 2 pages.
 Final Office Action for U.S. Appl. No. 12/072,187 mailed Jun. 13, 2011, 21 pages.
 Non-final Office Action for U.S. Appl. No. 12/072,187 mailed Nov. 30, 2010, 17 pages.
 Non-final Office Action for U.S. Appl. No. 12/892,280 mailed Nov. 6, 2012, 4 pages.
 Non-final Office Action for U.S. Appl. No. 13/083,110 mailed Dec. 12, 2012, 9 pages.
 International Search Report for PCT/US2009/057140 mailed Nov. 9, 2009, 2 pages.
 Examiner's Answer to Appeal Brief for U.S. Appl. No. 12/323,385 mailed Feb. 21, 2013, 11 pages.
 Final Office Action for U.S. Appl. No. 12/625,341 mailed Feb. 12, 2013, 10 pages.
 Advisory Action for U.S. Appl. No. 12/625,341 mailed Apr. 25, 2013, 6 pages.
 Non-final Office Action for U.S. Appl. No. 12/625,341 mailed Oct. 16, 2012, 8 pages.
 Non-final Office Action for U.S. Appl. No. 12/323,385 mailed Sep. 21, 2011, 10 pages.
 Final Office Action for U.S. Appl. No. 12/323,385 mailed Mar. 6, 2012, 12 pages.
 Final Office Action for U.S. Appl. No. 12/751,860 mailed Nov. 5, 2012, 6 pages.
 Non-final Office Action for U.S. Appl. No. 12/751,860 mailed Jul. 18, 2012, 8 pages.

Final Office Action for U.S. Appl. No. 13/275,798 mailed Jun. 27, 2013, 10 pages.
 Non-final Office Action for U.S. Appl. No. 13/275,798 mailed Mar. 1, 2013, 8 pages.
 Final Office Action for U.S. Appl. No. 13/177,233 mailed Mar. 29, 2013, 9 pages.
 Advisory Action for U.S. Appl. No. 13/177,233 mailed Jul. 17, 2013, 3 pages.
 Non-final Office Action for U.S. Appl. No. 13/177,233 mailed Dec. 17, 2012, 7 pages.
 Non-final Office Action for U.S. Appl. No. 10/804,958 mailed Jul. 22, 2009, 8 pages.
 Final Office Action for U.S. Appl. No. 10/804,958 mailed Jun. 11, 2008, 9 pages.
 Non-final Office Action for U.S. Appl. No. 10/804,958 mailed Aug. 30, 2013, 11 pages.
 Notice of Allowance for U.S. Appl. No. 10/804,958 mailed May 24, 2013, 8 pages.
 Decision on Appeal for U.S. Appl. No. 10/804,958 mailed Apr. 18, 2013, 9 pages.
 Examiner's Answer to Appeal Brief for U.S. Appl. No. 10/804,958 mailed Apr. 29, 2010, 12 pages.
 Final Office Action for U.S. Appl. No. 10/804,958 mailed Oct. 9, 2007, 8 pages.
 Non-final Office Action for U.S. Appl. No. 10/804,958 mailed Jun. 15, 2007, 7 pages.
 Final Office Action for U.S. Appl. No. 10/804,958 mailed Nov. 3, 2006, 7 pages.
 Non-final Office Action for U.S. Appl. No. 10/804,958 mailed Apr. 6, 2006, 7 pages.
 Non-final Office Action for U.S. Appl. No. 10/804,958 mailed Sep. 21, 2005, 7 pages.
 Notice of Allowance for U.S. Appl. No. 11/595,723 mailed Dec. 28, 2010, 8 pages.
 Non-final Office Action for U.S. Appl. No. 11/595,723 mailed Jun. 21, 2010, 9 pages.
 Non-final Office Action for U.S. Appl. No. 11/595,723 mailed Jan. 5, 2010, 9 pages.
 Advisory Action for U.S. Appl. No. 11/595,723 mailed Nov. 24, 2009, 3 pages.
 Final Office Action for U.S. Appl. No. 11/595,723 mailed Jul. 8, 2009, 13 pages.
 Non-final Office Action for U.S. Appl. No. 11/595,723 mailed Sep. 25, 2008, 13 pages.
 Final Office Action for U.S. Appl. No. 11/595,723 mailed Apr. 11, 2008, 12 pages.
 Non-final Office Action for U.S. Appl. No. 11/595,723 mailed Jun. 7, 2007, 18 pages.
 Examiner's Answer to Appeal Brief for U.S. Appl. No. 11/975,440 mailed Oct. 22, 2010, 17 pages.
 Final Office Action for U.S. Appl. No. 11/975,440 mailed Mar. 8, 2010, 10 pages.
 Non-final Office Action for U.S. Appl. No. 11/975,440 mailed Oct. 28, 2009, 7 pages.
 Non-final Office Action for U.S. Appl. No. 11/975,440 mailed Jul. 10, 2009, 6 pages.
 Notice of Allowance for U.S. Appl. No. 12/566,191 mailed May 24, 2011, 5 pages.
 Final Office Action for U.S. Appl. No. 12/566,191 mailed Feb. 15, 2011, 8 pages.
 Non-Final Office Action for U.S. Appl. No. 12/566,191 mailed Sep. 30, 2010, 8 pages.
 Monroe et al., "Holey Fibers with random cladding distributions," Optic Letters, vol. 25, No. 4, Feb. 15, 2000, 3 pages.
 Notice of Allowance for U.S. Appl. No. 11/499,572 mailed Jul. 1, 2010, 7 pages.
 Advisory Action for U.S. Appl. No. 11/499,572 mailed Jan. 27, 2010, 3 pages.
 Final Office Action for U.S. Appl. No. 11/499,572 mailed Aug. 12, 2009, 9 pages.
 Advisory Action for U.S. Appl. No. 11/499,572 mailed May 29, 2009, 3 pages.
 Final Office Action for U.S. Appl. No. 11/499,572 mailed Dec. 26, 2008, 8 pages.
 Non-final Office Action for U.S. Appl. No. 11/499,572 mailed Jun. 13, 2008, 7 pages.

(56)

References Cited

OTHER PUBLICATIONS

Notice of Allowance for U.S. Appl. No. 12/012,144 mailed Feb. 10, 2009, 6 pages.
 Non-final Office Action for U.S. Appl. No. 12/012,144 mailed Jul. 15, 2008, 5 pages.
 Notice of Allowance for U.S. Appl. No. 11/712,168 mailed Apr. 21, 2010, 9 pages.
 Notice of Allowance for U.S. Appl. No. 11/712,168 mailed Sep. 18, 2009, 9 pages.
 Notice of Allowance for U.S. Appl. No. 11/712,168 mailed Jun. 1, 2009, 7 pages.
 Notice of Allowance for U.S. Appl. No. 11/712,168 mailed Apr. 7, 2009, 9 pages.
 Advisory Action for U.S. Appl. No. 11/712,168 mailed Oct. 20, 2008, 3 pages.
 Final Office Action for U.S. Appl. No. 11/712,168 mailed Jul. 24, 2008, 11 pages.
 Non-final Office Action for U.S. Appl. No. 11/712,168 mailed Oct. 9, 2007, 7 pages.
 Advisory Action for U.S. Appl. No. 11/809,390 mailed Dec. 14, 2009, 2 pages.
 Final Office Action for U.S. Appl. No. 11/809,390 mailed Sep. 25, 2009, 12 pages.
 Non-final Office Action for U.S. Appl. No. 11/809,390 mailed Mar. 11, 2009, 9 pages.
 Notice of Allowance for U.S. Appl. No. 11/809,390 mailed Nov. 18, 2008, 7 pages.
 Non-final Office Action for U.S. Appl. No. 11/809,390 mailed Jul. 25, 2008, 10 pages.
 Non-final Office Action for U.S. Appl. No. 11/439,070 mailed Jun. 17, 2009, 9 pages.
 Non-final Office Action for U.S. Appl. No. 11/439,070 mailed Oct. 17, 2008, 13 pages.
 Non-final Office Action for U.S. Appl. No. 11/439,070 mailed Jan. 11, 2008, 11 pages.
 Non-final Office Action for U.S. Appl. No. 11/439,070 mailed May 16, 2007, 16 pages.
 Final Office Action for U.S. Appl. No. 12/229,810 mailed Jun. 9, 2011, 16 pages.
 Non-final Office Action for U.S. Appl. No. 12/229,810 mailed Dec. 23, 2010, 16 pages.
 Final Office Action for U.S. Appl. No. 13/083,110 mailed Aug. 5, 2013, 13 pages.
 Notice of Allowance for U.S. Appl. No. 12/417,250 mailed Nov. 9, 2011, 8 pages.
 Decision on Appeal for U.S. Appl. No. 11/975,440 mailed Nov. 4, 2013, 10 pages.
 Advisory Action for U.S. Appl. No. 13/083,110 mailed Nov. 12, 2013, 3 pages.
 Advisory Action for U.S. Appl. No. 13/275,798 mailed Sep. 12, 2013, 2 pages.
 Examiner's Answer to the Appeal Brief for U.S. Appl. No. 12/072,187 mailed Dec. 19, 2014, 25 pages.
 Final Office Action for U.S. Appl. No. 13/083,110 mailed Nov. 7, 2014, 20 pages.
 Non-Final Office Action for U.S. Appl. No. 13/362,474 mailed Dec. 5, 2014, 8 pages.
 Non-Final Office Action for U.S. Appl. No. 13/089,692 mailed Dec. 2, 2014, 7 pages.
 Notice of Allowance for U.S. Appl. No. 13/537,753 mailed Dec. 12, 2014, 7 pages.
 Advisory Action for U.S. Appl. No. 13/275,842 mailed Nov. 20, 2014, 3 pages.
 Non-Final Office Action for U.S. Appl. No. 13/648,811 mailed Oct. 24, 2014, 10 pages.
 Non-final Office Action for U.S. Appl. No. 13/479,846 mailed Sep. 13, 2013, 11 pages.
 Non-final Office Action for U.S. Appl. No. 13/613,759 mailed Sep. 20, 2013, 10 pages.

Tanji et al., "Optical Fiber Cabling Technologies for Flexible Access Network," Optical Fiber Technology, Academic Press, London, US, vol. 14, No. 3, Jul. 1, 2008, 8 pages.
 Non-final Office Action for U.S. Appl. No. 12/072,187 mailed Dec. 26, 2013, 25 pages.
 Final Office Action for U.S. Appl. No. 10/804,958 mailed Mar. 11, 2014, 13 pages.
 Notice of Allowance for U.S. Appl. No. 11/975,440 mailed Jan. 15, 2014, 7 pages.
 Non-final Office Action for U.S. Appl. No. 13/087,765 mailed Sep. 18, 2013, 8 pages.
 Final Office Action for U.S. Appl. No. 13/479,846 mailed Feb. 14, 2014, 11 pages.
 Final Office Action for U.S. Appl. No. 13/613,759 mailed Jan. 27, 2014, 13 pages.
 Non-final Office Action for U.S. Appl. No. 13/083,110 mailed Mar. 18, 2014, 14 pages.
 International Search Report for PCT/US2011/030466 mailed Aug. 5, 2011, 4 pages.
 Non-final Office Action for U.S. Appl. No. 13/094,572 mailed Jan. 18, 2013, 17 pages.
 Final Office Action for U.S. Appl. No. 13/094,572 mailed Jul. 8, 2013, 13 pages.
 Advisory Action for U.S. Appl. No. 13/094,572 mailed Oct. 7, 2013, 2 pages.
 Non-final Office Action for U.S. Appl. No. 13/094,572 mailed Mar. 4, 2014, 14 pages.
 Advisory Action for U.S. Appl. No. 13/613,759 mailed Apr. 7, 2014, 3 pages.
 Non-final Office Action for U.S. Appl. No. 13/649,377 mailed Jan. 31, 2014, 5 pages.
 International Search Report for PCT/US2011/030446 mailed Jul. 14, 2011, 3 pages.
 International Search Report for PCT/US2011/030448 mailed Jul. 20, 2011, 5 pages.
 Advisory Action for U.S. Appl. No. 10/804,958 mailed Jun. 26, 2014, 4 pages.
 Notice of Allowance for U.S. Appl. No. 11/975,440 mailed Apr. 30, 2014, 8 pages.
 Final Office Action for U.S. Appl. No. 12/072,187 mailed May 27, 2014, 27 pages.
 Non-final Office Action for U.S. Appl. No. 13/089,692 mailed Jan. 13, 2014, 8 pages.
 Non-final Office Action for U.S. Appl. No. 13/089,692 mailed May 5, 2014, 7 pages.
 Final Office Action for U.S. Appl. No. 13/089,692 mailed Aug. 13, 2014, 8 pages.
 Advisory Action for U.S. Appl. No. 13/089,692 mailed Oct. 22, 2014, 2 pages.
 Notice of Allowance and Interview Summary for U.S. Appl. No. 13/094,572 mailed Aug. 7, 2014, 11 pages.
 Examiner's Answer to the Appeal Brief for U.S. Appl. No. 13/275,798 mailed Aug. 26, 2014, 6 pages.
 Advisory Action for U.S. Appl. No. 13/479,846 mailed May 8, 2014, 3 pages.
 Non-final Office Action for U.S. Appl. No. 13/537,753 mailed Mar. 27, 2014, 7 pages.
 Notice of Allowance for U.S. Appl. No. 13/537,753 mailed Aug. 21, 2014, 7 pages.
 Examiner's Answer to the Appeal Brief for U.S. Appl. No. 13/613,759 mailed Aug. 18, 2014, 6 pages.
 Final Office Action for U.S. Appl. No. 13/649,377 mailed May 29, 2014, 8 pages.
 Non-final Office Action for U.S. Appl. No. 14/093,636 mailed Oct. 10, 2014, 6 pages.
 Non-final Office Action for U.S. Appl. No. 13/275,842 mailed Nov. 13, 2013, 7 pages.
 Final Office Action for U.S. Appl. No. 13/275,842 mailed Aug. 28, 2014, 20 pages.

* cited by examiner

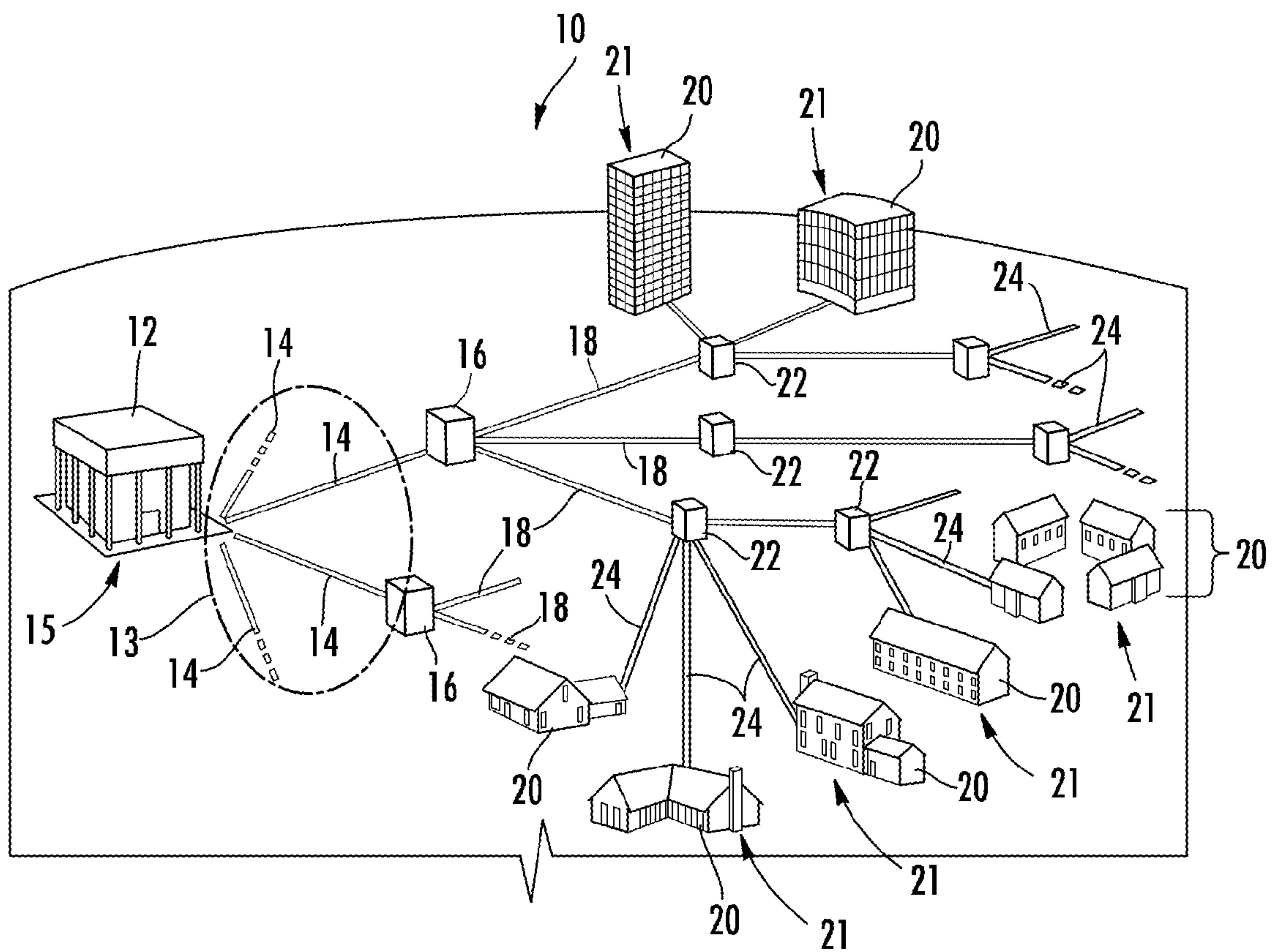


FIG. 1

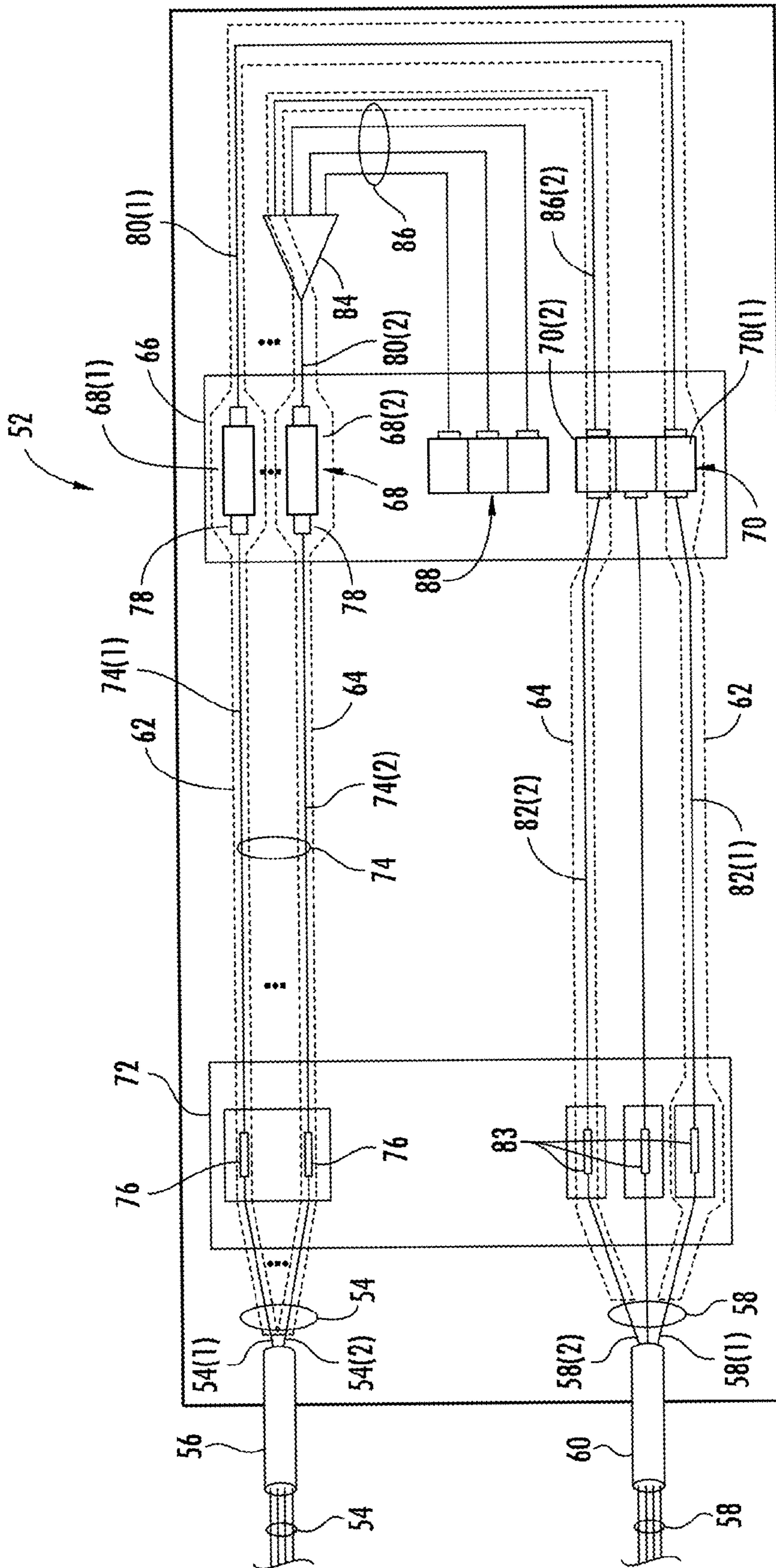


FIG. 3

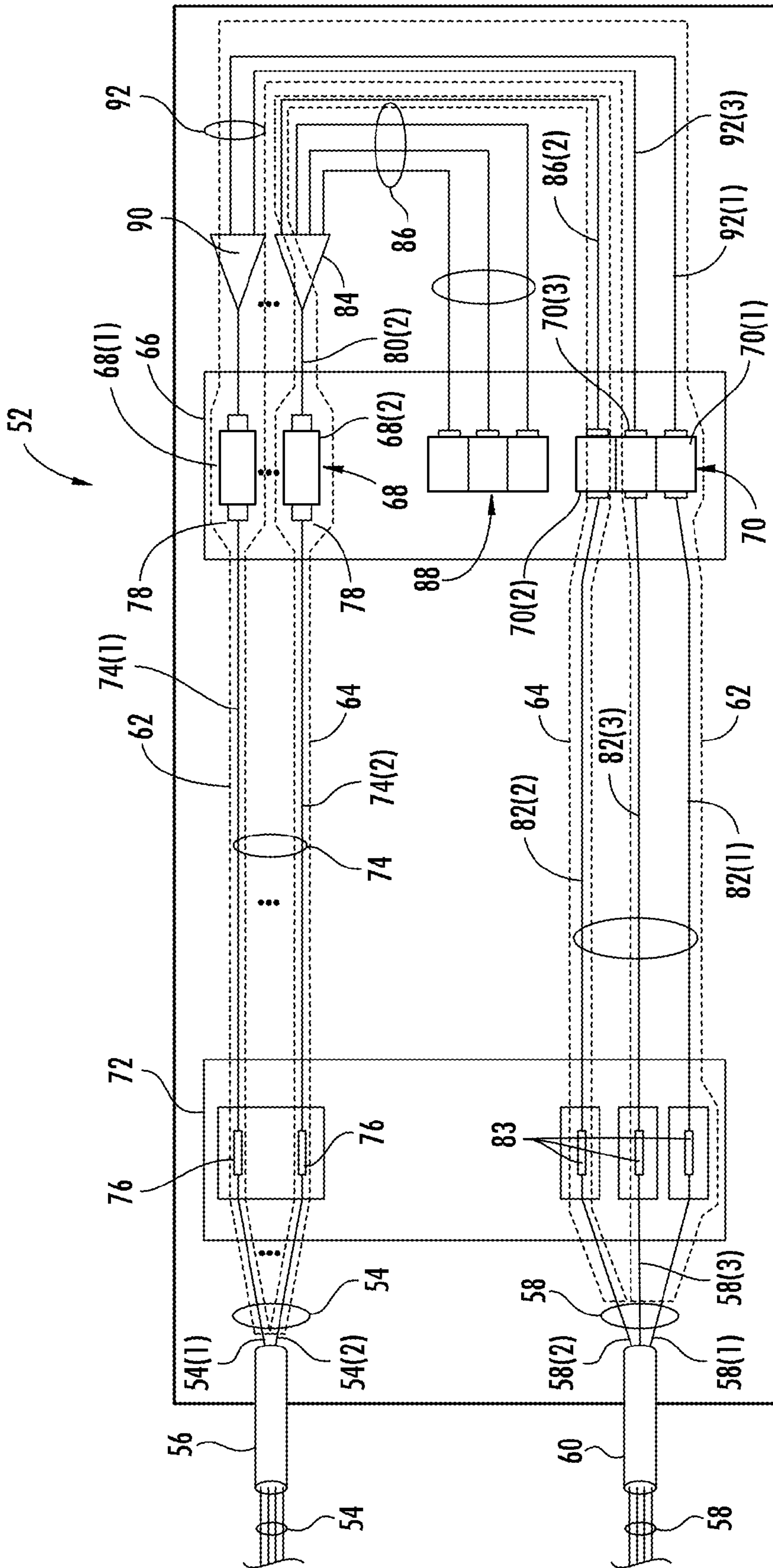


FIG. 4

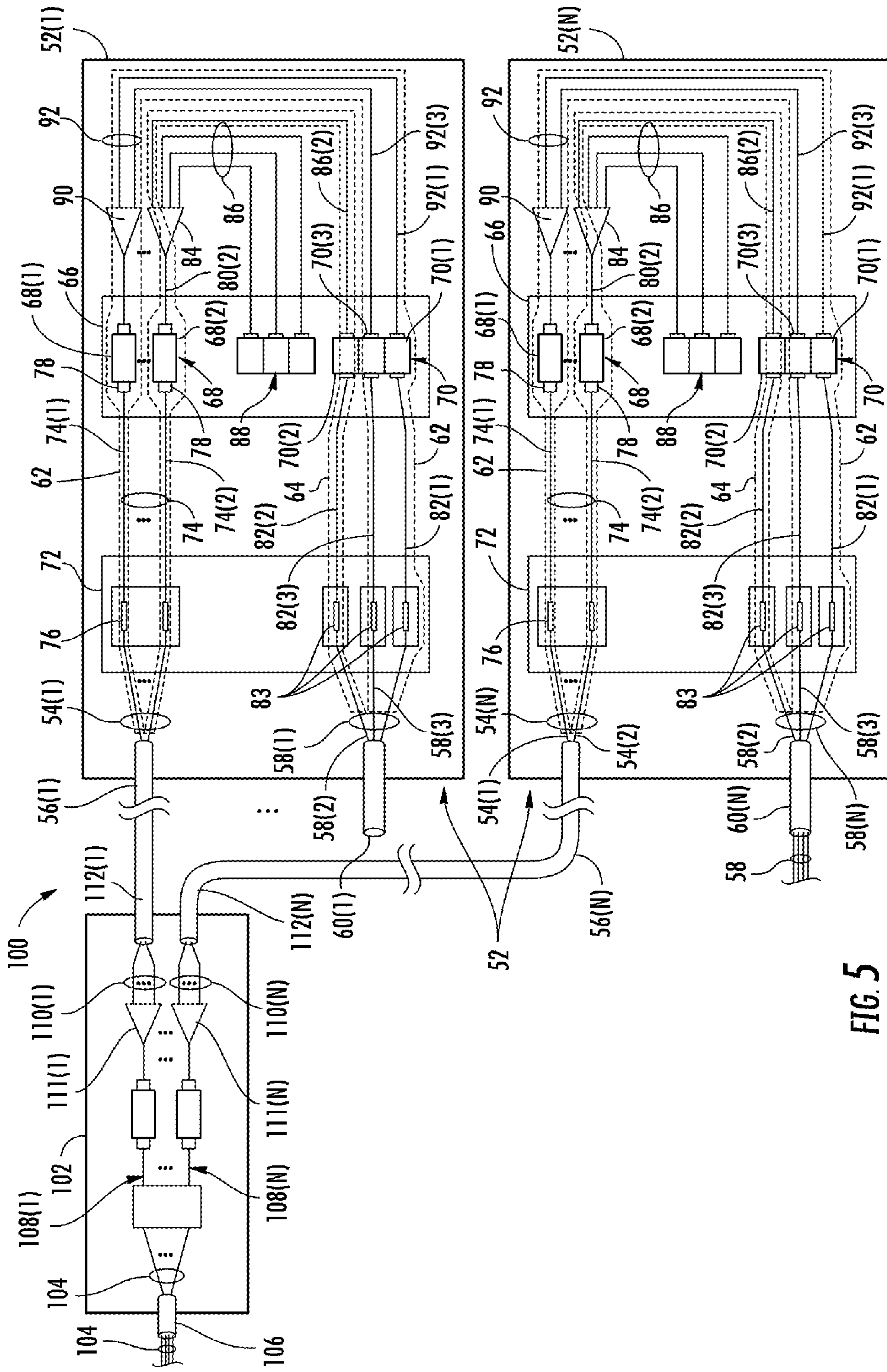


FIG. 5

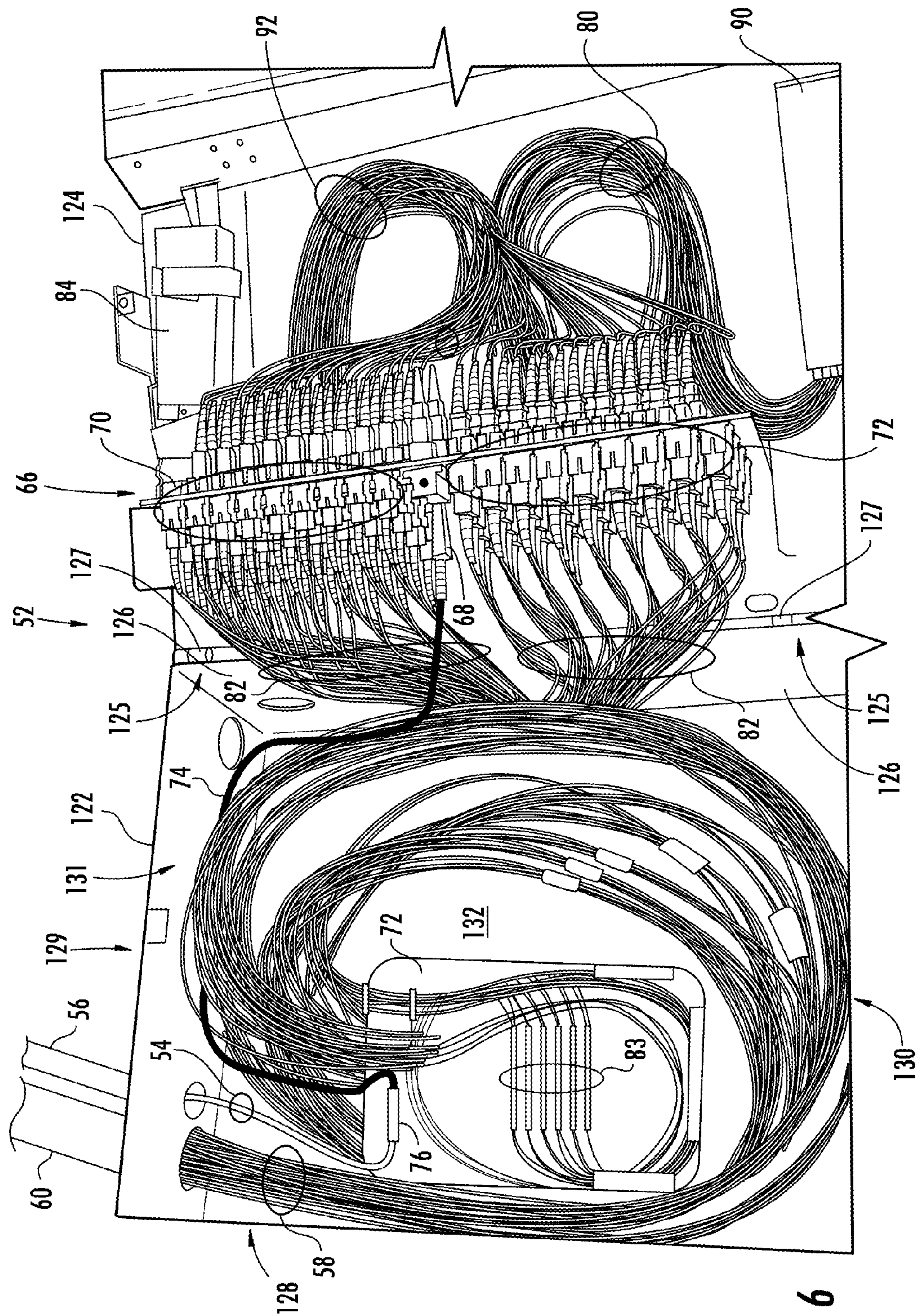


FIG. 6

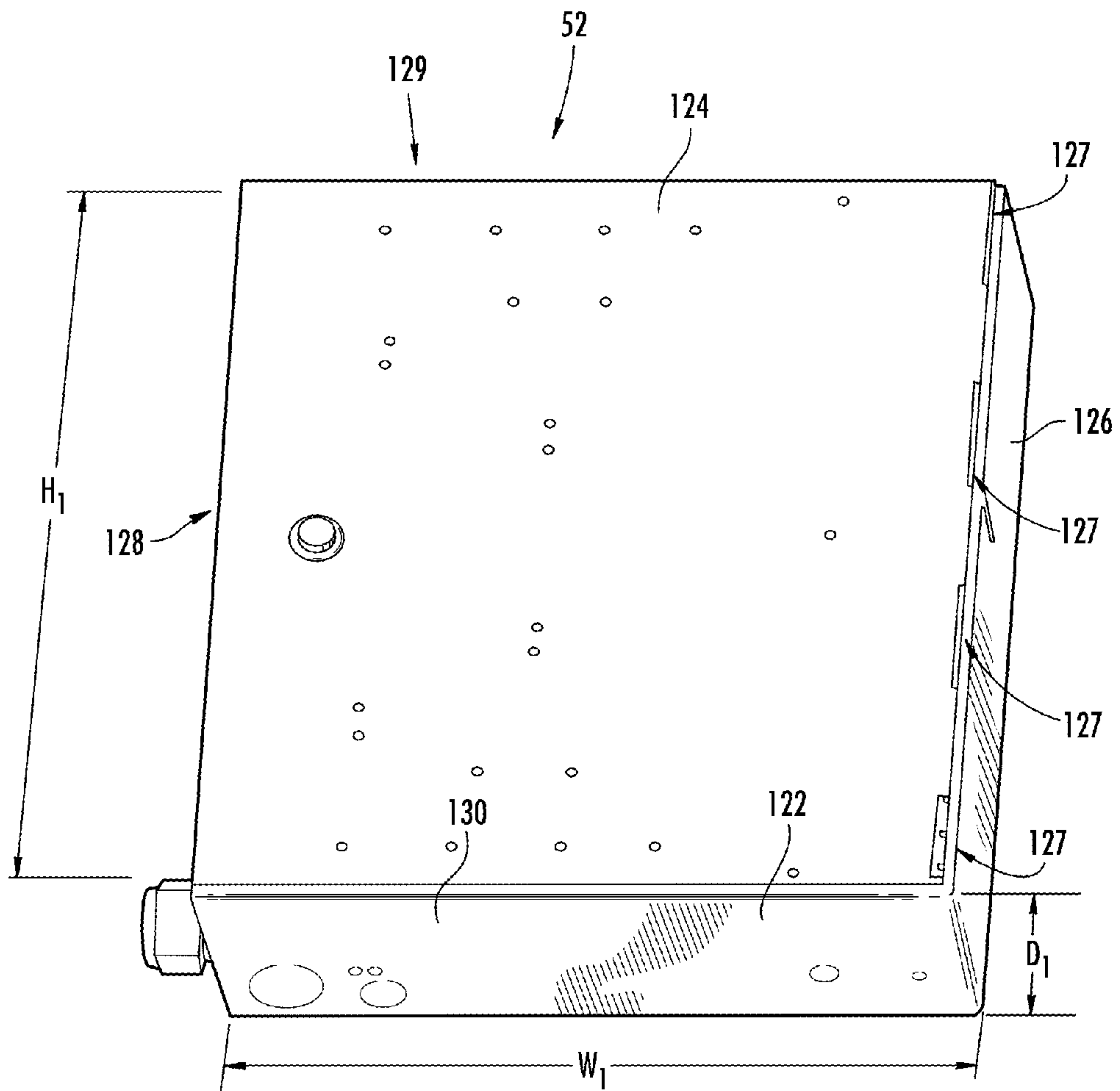


FIG. 7

FIBER OPTIC TERMINALS, SYSTEMS, AND METHODS FOR NETWORK SERVICE MANAGEMENT

RELATED APPLICATIONS

This is a continuation of U.S. patent application Ser. No. 12/630,938 filed on Dec. 4, 2009, the content of which is relied upon and incorporated herein by reference in its entirety, and the benefit of priority under 35 U.S.C. §120 is hereby claimed.

BACKGROUND

1. Field of the Disclosure

The technology of the disclosure relates to fiber optic terminals, systems, and methods for providing differentiated network services and/or differentiated network service overlays to subscribers of a fiber optic network.

2. Technical Background

To provide improved performance to subscribers, communication and data networks are increasingly employing optical fiber. The benefits of optical fiber are well known and include higher signal-to-noise ratios and increased bandwidth. To further improve performance, fiber optic networks are increasingly providing optical fiber connectivity all the way to end subscribers. These initiatives include various fiber-to-the-premises (FTTP), fiber-to-the-home (FTTH), and other fiber initiatives (generally described as FTTx). In this regard, FIG. 1 illustrates an exemplary fiber optic network 10. The fiber optic network 10 in this example is a passive optical network (PON). A PON is a point-to-multipoint FTTx network architecture to enable an optical fiber to serve multiple premises. A PON configuration generally reduces the amount of optical fiber and central office equipment as compared with point-to-point optical network architectures.

The fiber optic network 10 in FIG. 1 provides optical signals from switching points 12 over a distribution network 13 comprised of fiber optic feeder cables 14. The switching points 12 include optical line terminals (OLTs) or forward lasers/return receivers 15 that convert electrical signals to and from optical signals. The optical signals may then be carried over the fiber optic feeder cables 14 to local convergence points (LCPs) 16. The LCPs 16 act as consolidation points for splicing and making cross-connections and interconnections, as well as providing locations for optical couplers and splitters. The optical couplers and splitters in the LCPs 16 enable a single optical fiber to serve multiple subscriber premises 20. Fiber optic cables 18, such as distribution cables, exit the LCPs 16 to carry optical signals between the fiber optic network 10 and the subscriber premises 20. Typical subscriber premises 20 include single-dwelling units (SDU), multi-dwelling units (MDU), businesses, and/or other facilities or buildings. End subscribers in the subscriber premises 20 may contain network devices configured to receive electrical signals as opposed to optical signals. Thus, optical network terminals (ONTs) and/or optical network units (ONUs) 21 may be provided at the subscriber premises 20 to convert optical signals received over the fiber optic cables 18 to electronic signals.

Because LCPs 16 are typically configured to service multiple premises 20, the fiber optic cables 18 leaving the LCPs 16 are typically run to one or more intermediate fiber distribution terminals (FDTs) 22. FDTs 22 facilitate FTTx applications by providing network access points to the fiber optic network 10 to groupings of subscriber premises 20. Optical

interconnections to the subscriber premises 20 are typically provided via indoor/outdoor drop cables 24 that are optically interconnected with the fiber optic cables 18 within the FDTs 22. The FDTs 22 also provide a consolidated location for technicians or other installation personnel to make and protect splices and/or connections between the drop cables 24 and the fiber optic cables 18 as opposed to making splices and/or connections in sporadic locations.

The fiber optic network 10 is capable of providing different levels of network services to subscriber premises 20 and different end subscribers at multi-unit subscriber premises 20. In this manner, different end subscribers can be charged at different rates based on their selected level of service. For example, the fiber optic network 10 may be capable of providing a premium, faster data-rate service to subscriber premises 20. However, some end subscribers at subscriber premises 20 may not need or desire the bandwidth provided in the premium data service. In this regard, the ONT and/or ONU 21 deployed at the subscriber premises 20 may be configured to control the level of service to only allow a standard, slower data-rate service. This is because the fiber optic network 10 in FIG. 1 is homogeneous, meaning the highest level of service available is provided over all fiber optic feeder cables 14 and fiber optic cables 18 regardless of whether each subscriber premises 20 has subscribed to the highest level of service.

When setting up a PON, service operators must consider providing ONUs that support differentiated services, such as higher bandwidth services and/or packet delivery assured services to service future potential increased bandwidth needs and demands of end subscribers. Some examples of these services include Ethernet PON (EPON), Gigabit PON (GPON), ten (10) Gigabit EPON (10 G-EPON), 10 G-GPON, WDM-based network services, such as for example, Wave Division Multiplexing PON (WDM-PON). The ONUs must be configured to recognize and transfer PON services provided by the PON. One approach is to delay providing ONUs that support differentiated PON services until demand or need exists. The initial costs may be less using this approach. However, this approach would also require eventually swapping-out initially installed ONUs with ONUs that support the differentiated PON services supported by the PON, thus increasing total cost and potentially disrupting service to subscribers.

Another approach is to initially pre-position ONUs capable of supporting differentiated PON services (e.g., EPON, GPON, 10 G-EPON, 10 G-GPON, and WDM-PON) in advance of supporting revenue streams. This approach may be necessary if it is desired to provide certain end subscribers with differentiated services. It may also be desired to provide different types of PON services to different end subscribers which may be closely located to each other. For example, it may be desirable to service closely located business end subscribers and residential end subscribers off of the same network even though business subscribers typically subscribe to differentiated PON services. However, initial costs of providing ONUs capable of supporting differentiated PON services may be initially higher than using the delay approach.

SUMMARY OF THE DETAILED DESCRIPTION

Embodiments disclosed in the detailed description include fiber optic terminals, systems, and methods for providing different (i.e., differentiated) network services to subscribers of a fiber optic network. A network service refers to a technology or platform used to carry or deliver an application, product, or service. In certain embodiments, fiber optic ter-

minals, systems, and methods are disclosed for providing more than one network service over a fiber optic network to subscribers supported by the same fiber optic terminal. As a result, the optical paths in the fiber optic terminal do not have to be homogeneous wherein each optical path would carry the same optical signals and thus the same network services. Thus, differentiated levels and/or types of network services can be provided to different subscribers supported by the same fiber optic terminal. Further, by providing multiple optical paths in the fiber optic terminal, additional network services can be migrated to a fiber optic terminal, wherein subscribers supported by the same fiber optic terminal can subscribe to different services. Further, the network services provided to a subscriber supported by the fiber optic terminal can be reconfigured by changing the optical path connected to the subscriber in the fiber optic terminal. Further, by employing the fiber optic terminal, it may not be necessary to provide or upgrade optical network terminals (ONTs) or optical network units (ONUs) for subscribers to discriminate between different types of network services since the optical paths in the fiber optic terminal are not homogeneous.

In this regard, in one embodiment, a fiber optic terminal is provided. The fiber optic terminal comprises a first optical path connected to a first network-side optical fiber providing a first network service to a first subscriber-side optical fiber. The fiber optic terminal also comprises a second optical path connected to a second network-side optical fiber providing a second network service different from the first network service to a second subscriber-side optical fiber. In this manner, different or differentiated network services can be provided to different subscribers supported by the same fiber optic terminal by connecting subscribers to an optical path in the fiber optic terminal providing the desired network services. The fiber optic terminal can become the management point to connect subscribers to the desired network services. The network services provided on the optical paths in the fiber optic terminals may also be overlays of multiple network services.

In other embodiments, methods of providing at least two different network services to subscribers supported by a fiber optic terminal are disclosed. In one embodiment, the method comprises providing a fiber optic terminal. The method also comprises connecting a first optical path in the fiber optic terminal to a first network-side optical fiber providing a first network service. The method further comprises connecting the first optical path to at least one first subscriber-side optical fiber to provide the first network service to at least one first subscriber connected to the at least one first subscriber-side optical fiber. The method also comprises connecting a second optical path in the fiber optic terminal to a second network-side optical fiber providing a second network service different from the first network service.

In other embodiments, fiber optic systems are disclosed. In one embodiment, a fiber optic system comprises a network-side fiber optic terminal. The network-side fiber optic terminal comprises a first network-side optical path connected to a first network-side optical fiber providing a first network service to a first optical fiber. The network-side fiber optic terminal also comprises a second network-side optical path connected to a second network-side optical fiber providing a second network service different from the first network service to a second optical fiber. The fiber optic system also comprises a first subscriber-side fiber optic terminal comprising a first optical path connected to the first optical fiber to provide the first network service to at least one first subscriber connected to the first subscriber-side fiber optic terminal. In this manner, the connection of the first subscriber-side terminal to the first optical fiber provides the first network service

provided by the network-side fiber optic terminal to subscribers supported by the first subscriber-side fiber optic terminal. In this manner, the network service provided to the first subscriber-side network terminal is controlled by the connection of the first optical path to an optical fiber from the network-side fiber optic terminal.

The fiber optic terminals can be any type of fiber optic terminal. Examples include local convergence points (LCPs) and fiber distribution terminals (FDTs). The fiber optic terminals can support subscriber premises, end subscribers, or other subscribers on the network-side of end subscribers or subscriber premises. The first and/or second optical paths may include optical splitters to split the first and/or second network services provided to multiple subscribers supported by the fiber optic terminal. Further, the first and/or second optical paths may include non-split fiber optic connections to provide a network service carried over an optical path to a single subscriber supported by the fiber optic terminal.

Additional features and advantages will be set forth in the detailed description which follows, and in part will be readily apparent to those skilled in the art from that description or recognized by practicing the embodiments as described herein, including the detailed description that follows, the claims, as well as the appended drawings.

It is to be understood that both the foregoing general description and the following detailed description present embodiments, and are intended to provide an overview or framework for understanding the nature and character of the disclosure. The accompanying drawings are included to provide a further understanding, and are incorporated into and constitute a part of this specification. The drawings illustrate various embodiments, and together with the description serve to explain the principles and operation of the concepts disclosed.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 illustrates an exemplary passive optical network (PON) that includes optical network terminals (ONTs) and optical network units (ONUs) for converting electrical signals to optical signals, and vice versa, and fiber optic terminals for carrying optical signals over a fiber optic network;

FIG. 2 illustrates an exemplary multi-dwelling unit (MDU) that includes fiber optic terminals that include local convergence points (LCPs) and fiber distribution terminals (FDTs) providing connectivity of end subscribers to the fiber optic network;

FIG. 3 is a block diagram of an exemplary fiber optic terminal employing a first non-split optical path and a second optical path employing an optical splitter, wherein each optical path supports different network services in a centralized manner;

FIG. 4 is a block diagram of another exemplary fiber optic terminal employing optical splitters in each optical path, wherein each optical path supports different network services in a centralized manner;

FIG. 5 is a block diagram of an exemplary network-side fiber optic terminal providing one or more network services to subscribers supported by one or more subscriber-side fiber optic terminal(s) connected to the network-side fiber optic terminal in a distributed manner;

5

FIG. 6 is an exemplary fiber optic terminal that may be employed as any of the aforementioned fiber optic terminals; and

FIG. 7 illustrates the fiber optic terminal of FIG. 6 with a terminal cover closed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the embodiments, examples of which are illustrated in the accompanying drawings, in which some, but not all embodiments are shown. Indeed, the concepts may be embodied in many different forms and should not be construed as limiting herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Whenever possible, like reference numbers will be used to refer to like components or parts.

Embodiments disclosed in the detailed description include fiber optic terminals, systems, and methods for providing different (i.e., differentiated) network services to subscribers of a fiber optic network. A network service refers to a technology or platform used to carry or deliver an application, product, or service. In certain embodiments, fiber optic terminals, systems, and methods are disclosed for providing more than one network service over a fiber optic network to subscribers supported by the same fiber optic terminal. As a result, the optical paths in the fiber optic terminal do not have to be homogeneous wherein each optical path would carry the same optical signals and thus the same network services. Thus, differentiated levels and/or types of network services can be provided to different subscribers supported by the same fiber optic terminal. Further, by providing multiple optical paths in the fiber optic terminal, additional network services can be migrated to a fiber optic terminal, wherein subscribers supported by the same fiber optic terminal can subscribe to different services. As an example, the fiber optic terminal may allow a service operator to design a network that initially provides Radio Frequency over Glass (RfOG) based services to subscribers, but the network and the fiber optic terminal may be later migrated to additionally provide differentiated PON services (e.g., EPON, GPON, 10 G-EPON, 10 G-GPON, and WDM-PON), including but not limited to higher bandwidth services, to subscribers supported by the fiber optic terminal. The network services provided to a subscriber supported by the fiber optic terminal can be reconfigured by changing the optical path connected to the subscriber in the fiber optic terminal. Further, by employing the fiber optic terminal, it may not be necessary to provide or upgrade optical network terminals (ONTs) or optical network units (ONUs) for subscribers to discriminate between different types of network services since the optical paths in the fiber optic terminal are not homogeneous.

In this regard, in one embodiment, a fiber optic terminal is provided. The fiber optic terminal comprises a first optical path connected to a first network-side optical fiber providing a first network service to a first subscriber-side optical fiber. The fiber optic terminal also comprises a second optical path connected to a second network-side optical fiber providing a second network service different from the first network service to a second subscriber-side optical fiber. In this manner, different network services can be provided to different subscribers supported by the same fiber optic terminal by connecting subscribers to an optical path in the fiber optic terminal providing the desired network services. The fiber optic terminal can become the management point to connect subscribers to the desired network services. The network services

6

provided on the optical paths in the fiber optic terminals may also be overlays of multiple network services (e.g., provided over the same fiber).

The fiber optic terminals disclosed herein may be used for any type of fiber optic terminal, including but not limited to local convergence points (LCPs) and fiber distribution terminals (FDTs). For example, if the fiber optic terminal is configured as a local convergence point (LCP), the network-side or upstream fiber optic cable may be a feeder cable from a central office, head end, or switching point. The subscriber-side or downstream fiber optic cable may be a distribution cable. If the fiber optic terminal is configured as an FDT, the network-side or upstream fiber optic cable may be a distribution cable, and the subscriber-side or downstream fiber optic cable may be a drop cable. The drop cable may then be routed to an end subscriber(s) for FTTx applications.

The fiber optic terminals disclosed herein may be installed in any location or premises. The fiber optic terminal may be employed for providing fiber optic network connectivity to end subscribers in multi-dwelling units (MDUs). In this regard, FIG. 2 illustrates a MDU 30 that includes fiber optic terminals 31 that may be employed as both LCPs 32 and FDTs 34. If the fiber optic terminal is configured as an FDT, the network-side or upstream fiber optic cable may be a distribution cable, and the subscriber-side or downstream fiber optic cable may be a drop cable. The drop cable may then be routed to an end subscriber(s) for FTTx applications.

The fiber optic terminals 31 provide convenient access points in a telecommunications or data network for a field technician to install and reconfigure optical fiber connections between network-side and subscriber-side fiber optic cables. The fiber optic terminals 31 are configured to allow one or more optical fibers provided in one or more network-side or upstream fiber optic cables to be easily and readily interconnected with one or more optical fibers in one or more subscriber-side or downstream fiber optic cables. By the term "subscriber-side," it is meant that optical fiber, fiber optic cable, or optical connection, as the case may be, is provided anywhere between the end subscriber and the fiber optic terminals 31. A subscriber-side fiber optic cable, optical fiber, or optical connection may be provided directly to an end subscriber or may be provided to one or more intermediate optical terminals or components before reaching an end subscriber. By the term "network-side," it is meant that the optical fiber, fiber optic cable, or optical connection, as the case may be, is provided between a fiber optic network, central switching point, central office, head end, or the like and the fiber optic terminals 31.

Before discussing various embodiments of fiber optic terminals that may be employed starting at FIG. 3, the exemplary MDU 30 in FIG. 2 is first discussed in more detail. In this regard, the MDU 30 in this example includes nine (9) dwelling units 38 for illustrative purposes only. In this embodiment, the LCP 32 is positioned on the ground floor or basement in the illustrated embodiment; however, the LCP 32 could be positioned at any location relative to the MDU 30. The LCP 32 includes a cable assembly 40 that is optically connected to a network-side fiber optic cable 42. For example, the network-side fiber optic cable 42 may be a feeder cable optically connected to a central office (not shown) or switching point (not shown) through a fiber optic network 44. One or more subscriber-side optical fibers 46 carrying optical signals can be optically connected in or at the LCP 32 to the fiber optic network 44 and exit the LCP 32 to extend throughout the MDU. For example, the subscriber-side optical fibers 46 may be distribution cables. The network-side fiber optic cables 42 may be feeder cables. The

subscriber-side optical fibers **46** carry optical signals to and from the LCP **32** received from the fiber optic network **44** and extend to each dwelling unit **38** via subscriber-side optical fibers **48** and eventually terminate at a subscriber termination point **50**, such as an adapter in a wall outlet, an adapter in a floor panel, an adapter behind a ceiling tile, or the like such that the subscriber can optically connect to a subscriber-side optical fiber **48**.

The optical fibers extended to the subscriber termination point **50** can be the subscriber-side optical fibers **46**, or can be provided by subscriber-side optical fibers **48** from one or more intermediate FDTs **34**. The FDTs **34** can be provided to simplify the routing and installation of the subscriber-side optical fibers **48** between the LCP **32** and the subscriber termination points **50** by allowing the subscriber-side optical fibers **48** to be grouped between the LCP **32** and FDTs **34** and then separated at the FDTs **34**. The FDTs **34** are configured to receive the subscriber-side optical fibers **46** and provide the individual subscriber-side optical fibers **48** to the subscriber termination points **50**. Accordingly, there are fewer optical fibers and/or fiber optic cables extending between the floors of the MDU **30**, thus simplifying routing of optical fibers through the MDU **30**. Although floors of the MDU **30** are described in the illustrated embodiments, it should be appreciated that FDTs **34** may be used to facilitate optical fiber routing to any layout of areas within the MDU **30**. Further, although the subscriber-side optical fibers **48** and subscriber-side optical fibers **46** include arrows pointing in the direction of the subscriber termination points **50**, it should be appreciated that optical signals may be passed in either direction as required for the particular application; the arrows are merely provided for illustrative purposes.

A block diagram of an exemplary embodiment of a fiber optic terminal **52** according to one embodiment is illustrated in FIG. **3**. The fiber optic terminal **52** in FIG. **3** may be provided as the fiber optic terminals **31** in FIG. **2**, including the LCPs **32** and FDTs **34** provided therein, as examples. As will be described in greater detail below, the fiber optic terminal **52** in this embodiment employs multiple optical paths that receive optical signals from a plurality of network-side optical fibers **54** disposed in a network-side fiber optic cable **56**. The network-side optical fibers **54** provide optical signals for a plurality of network services. The fiber optic terminal **52** facilitates providing the plurality of network services to subscribers (not shown) over subscriber-side optical fibers **58** disposed in a subscriber-side fiber optic cable **60**. In this manner, different network services can be provided to different subscribers supported by the same fiber optic terminal **52** by connecting subscribers to the optical path in the fiber optic terminal **52** providing the desired network services. In this regard, the fiber optic terminal **52** provides different network services to subscribers in a centralized manner. As a result, the optical paths in the fiber optic terminal **52** do not have to be homogeneous, meaning each optical path carries the same optical signals and thus the same network services.

Different levels and/or types of network services can be provided to different subscribers supported by the fiber optic terminal **52**. For example, as illustrated in FIG. **3**, a first optical path **62** provided in the fiber optic terminal **52** may be connected to a first network-side optical fiber **54(1)** providing Radio Frequency over Glass (RFOG) based network services. RFOG is compatible with head-end equipment in existing hybrid fiber coaxial (HFC) networks, and may provide voice, video, data, and/or services. A second optical path **64** provided in the fiber optic terminal **52** may be connected to a second network-side optical fiber **54(2)** providing Ethernet Passive Optical Network (EPON) based network services.

Thus, a first subscriber-side optical fiber(s) **58(1)** connected to the first optical path **62** and the first subscriber-side optical fiber(s) **54(1)** provides RFOG-based network services to subscribers connect thereto. A second subscriber-side optical fiber(s) **58(2)** connected to the second optical path **64** and the second network-side optical fiber **54(2)** provides EPON-based network services in this embodiment. In this manner, the fiber optic terminal **52** allows providing different network services to different subscribers supported by the fiber optic terminal **52**. Thus, discriminating between different types of network services through use of ONTs or ONUs at end subscribers may not be required to provide different network services to different subscribers supported by the fiber optic terminal **52**. Further, if at a later time it is desired, for example, to provide EPON-based network services to the first subscriber-side optical fiber **58(1)**, the connection of the first subscriber-side optical fiber **58(1)** can be moved or relocated to be connected to the second optical path **64** and the second network-side optical fiber **54(2)** in the fiber optic terminal **52**.

The fiber optic terminal **52** in FIG. **3** also supports overlaying of multiple network services in the first and second optical paths **62**, **64**. For example, optical signals providing EPON-based network services carried on the network-side optical fiber **54(2)** may be overlaid onto optical signals providing RFOG-based network services carried on the same network-side optical fiber **54(1)**. Overlaying means providing multiple optical signals over the same optical fiber (e.g., using wave division multiplexing (WDM) or time division multiplexing (TDM)). Overlaying of optical signals is possible where the overlaid network services are provided by optical signals having different wavelengths. This provides for greater flexibility in providing enhanced network services. As an example, the first and second optical paths **62**, **64** in the fiber optic terminal **52** may initially be connected to network-side optical fibers **54** that provide only one network service, for example, a RFOG-based network service. Later, when it is desired to provide enhanced bandwidth, additional network services, such as EPON-based or GPON-based network services as examples, can be overlaid on network-side optical fibers **54** such that one optical path **62** or **64** as the case may be, may provide network services using a combination of RFOG-based and EPON-based services to subscribers and the other optical path **64** or **62** may provide only network services using RFOG. For example, RFOG may provide video services, and EPON or GPON provide data and voice services. Thus, the providing of non-homogeneous optical paths in the fiber optic terminal **52** facilitates easy migration to differentiated network services, which includes but is not limited to higher bandwidth network services.

With continuing reference to FIG. **3**, the fiber optic terminal **52**, the network-side optical fibers **54** from the network-side fiber optic cable **56**, and the subscriber-side optical fibers **58** from the subscriber-side fiber optic cable **60** are optically connected to each other at a fiber optic connection panel **66** disposed in the fiber optic terminal **52** in this embodiment. The fiber optic connection panel **66** can be a panel or module that contains or supports a plurality of optical fiber connections. The fiber optic connection panel **66** may support one or more input fiber optic adapters **68** and one or more output fiber optic adapters **70** for supporting optical fiber connections. The input and output fiber optic adapters **68**, **70** support making optical connections between the one or more network-side optical fibers **54** from the network-side fiber optic cable **56** and the one or more subscriber-side optical fibers **58** from the subscriber-side fiber optic cable **60**. The input and

output fiber optic adapters **68**, **70** may be of any connection type, including but not limited to SC, LC, MTP, FC, ST, MU, or MTRJ.

With continuing reference to FIG. 3, to make an optical connection between the one or more network-side optical fibers **54**, the one or more network-side optical fibers **54** are spliced in a splice tray **72** to an input pigtail(s) **74** in a network splice(s) **76** in this embodiment. However, the fiber optic terminal **52** could be configured to not require splicing. The input pigtail(s) **74** is connected on a connectorized end(s) **78** to the input fiber optic adapter(s) **68**. In this embodiment, a first input pigtail **74(1)** optically connected to the first network-side optical fiber **54(1)** is connected to an input fiber optic adapter **68(1)**. An output fiber **80(1)** is connected between the input fiber optic adapter **68(1)** and an output fiber optic adapter **70(1)** to optically connect the network-side optical fiber **54(1)** to an output pigtail **82(1)**. The output pigtail **82(1)** is spliced, via splices **83** in the splice tray **72**, into the subscriber-side optical fiber **58(1)** in the subscriber-side fiber optic cable **60**. Again, splicing may not be required. In this manner, an optical connection is made between the network-side optical fiber **54(1)** and subscriber-side network optical fiber(s) **58(1)** to provide the first network service to a subscriber connected to the subscriber-side optical **58(1)** fiber.

Also in this embodiment of the fiber optic terminal **52**, a second input pigtail **74(2)** optically connected to the second network-side optical fiber **54(2)** is connected to an input fiber optic adapter **68(2)**. The input fiber optic adapter **68(2)** is connected to an output fiber **80(2)** which is an input into an optical splitter **84** provided in the second optical path **64**. The optical splitter **84** is configured to split optical signals carried by the input fiber **80(2)**, via connection to the input fiber optic adapter **68(2)**, into a plurality of optical signals carried by multiple connectorized output fibers **86(2)**. For example, the optical splitter **84** in FIG. 3 is a 1×4 optical splitter, but any other type of splitting configuration may be provided. Providing the optical splitter **84** in the second optical path **64** allows more than one subscriber-side optical fiber **58** to be connected to the second optical path **64** and thus receive the second network service, if desired. The splitter configuration of the optical splitter **84** depends on the number of subscribers desired to be provided with the second network service in this embodiment. For example, a 1×8 optical splitter allows the second optical path **64** to be connected to up to eight (8) subscriber-side optical fibers **58**.

With continuing reference to FIG. 3, one or more of the output fibers **86** can then be connected into one or more of the output fiber optic adapters **70** to optically connect to the output pigtails **82**. In this embodiment, one of the output fibers **86(2)** is connected to the output fiber optic adapter **70(2)**, which is optically connected to output pigtail **82(2)**. The output pigtail **82(2)** is spliced, via the splice tray **72**, into the subscriber-side optical fiber(s) **58(2)** in the subscriber-side fiber optic cable **60**. In this manner, an optical connection is made between the network-side optical fiber **54(2)** and subscriber-side optical fiber(s) **58(2)** to provide the second network service to a subscriber connected to the subscriber-side optical fiber **58(2)**.

If it is later desired to change, move, or relocate the subscriber-side optical fiber **58(1)** to the second network service over the second optical path **64**, the output pigtail **82(1)** can be connected to the optical splitter **84** through the fiber optic adapter **70** easily and quickly. In this regard, one of the output fibers **86** from the optical splitter **84** may need to be moved from a parking area **88**, where unused output fibers are parked, to a connection with an available output fiber optic

adapter **70** that is connected to the output pigtail **82(1)**. In the embodiment shown in FIG. 3, it is not possible to connect more than one subscriber-side optical fiber **58** to the first optical path **62** to receive the first network service since only one input fiber optic adapter **68(1)** is provided in the first optical path **62**. If it is desired to provide the ability for multiple subscriber-side optical fibers **58** to be connected to the first optical path **62** to receive the first network services, the fiber optic terminal **52** can be expanded by also providing an optical splitter in the first optical path **62**.

In this regard, FIG. 4 provides the fiber optic terminal **52** of FIG. 3, except that an optical splitter **90** is also provided in the first optical path **62**. In this manner, network services from the first network-side optical fiber **54(1)** can also be split into a plurality of output signals carried by multiple connectorized output fibers **92** that can be connected to one (1) or more subscriber-side optical fiber **58** to provide expansion of the first network service to additional subscribers, if needed or desired. Connectorized output fibers **92(1)**, **92(2)** from the optical splitter **90** are connected to output fiber optic adapters **70(1)**, **70(3)**, which are in turn connected to output pigtails **82(1)**, **82(3)**, respectively. The output pigtails **82(1)**, **82(3)** are connected to subscriber-side optical fibers **58(1)**, **58(3)**. In this regard, the first network services provided in the first optical path **62** can be provided to two (2) subscribers connected to subscriber-side optical fibers **58(1)**, **58(3)** in this embodiment. If it is desired to move, change, or relocate any subscribers from the first network service to the second network service, or vice versa, the subscriber-side optical fiber(s) **58** connected to such subscriber can be moved or relocated from the first optical path **62** (e.g., the optical splitter **90**) to the second optical path **64** (e.g., the optical splitter **84**), or vice versa. For example, if it is desired to move, change, or relocate a subscriber connected to subscriber-side optical fiber **58(1)** from the first network service to the second network service, the output pigtail **82(1)** can be moved or relocated to the output fiber optic adapter **70(2)**, or alternatively, output fiber **92(1)** from the optical splitter **90** can be moved or relocated to output fiber optic adapter **70(2)**.

FIG. 5 illustrates another embodiment where a fiber optic system **100** is provided that includes at least one network-side fiber optic terminal **102** to support providing multiple network services to multiple fiber optic terminals in a distributed manner. In this embodiment, the network-side fiber optic terminal **102** is configured to provide optical signals for more than one network service from a fiber optic network (not shown) received over multiple network-side optical fibers **104** provided in a network-side fiber optical cable **106**. In this regard, the network-side fiber optic terminal **102** may be configured like any configurations provided for the fiber optic terminals **52** previously discussed, as an example. The network-side fiber optic terminal **102** can be configured to provide multiple (N) optical paths **108(1)**-**108(N)** to provide multiple network services like configured in the fiber optic terminals **52** previously described.

In this embodiment, subscriber-side optical fibers **110(1)** provided in a fiber optic cable **112(1)** are connected to a network service to the optical path **108(1)** in the network-side fiber optic terminal **102** to provide a first network service. The subscriber-side optical fibers **110(1)** carry optical signals split by an optical splitter **111(1)**. The optical signals split by optical splitter **111(1)** are carried by network-side optical fibers **54(1)** routed to a first subscriber-side fiber optic terminal **52(1)** to provide the first network service to the first subscriber-side fiber optic terminal **52(1)**. The first subscriber-side fiber optic terminal **52(1)** can be the fiber optic terminals **52** previously described. In this manner, the net-

11

work service provided to subscribers supported by the first subscriber-side fiber optic terminal **52(1)** is provided through the optical splitter **111(1)** in the network-side fiber optic terminal **102** in a distributed manner. However, if optical path **108(N)** is connected to network-side optical fibers **106** providing a different network service from the network service provided to the optical path **108(1)**, and the network-side optical fibers **54(1)** are connected to the subscriber-side optical fibers **110(N)**, a different network service would be provided to the first subscriber-side fiber optic terminal **52(N)**. Thus, the number of optical paths **108(1)-108(N)** in the network-side fiber optic terminal **102** determines the number of different unique network services or network service overlays that can be provided to the first subscriber-side fiber optic terminal **52(1)** in the fiber optic system **100** of FIG. 5.

Further, if more than one network service is provided in the subscriber-side optical fibers **110(1)** in the network-side fiber optic terminal **102** to the first subscriber-side fiber optic terminal **52(1)**, the network services provided to subscribers supported by the first subscriber-side fiber optic terminal **52(1)** can also be determined in the subscriber-side fiber optic terminal **52** to provide a distributed configuring of network services. Different network services can be provided in different optical paths, for example, the first and second optical paths **62, 64**, within the first subscriber-side fiber optic terminal **52(1)** and provided to different subscriber-side optical fibers **58(1)**, as previously described with regard to FIGS. 3 and 4. For example, the optical splitter **111(1)** in the fiber optic terminal **102** may be a 1×4 splitter and the optical splitters **84, 90** in the fiber optic terminal **52(1)** may be 1×2 splitters, as opposed to, for example, only providing a 1×8 optical splitter in the fiber optic terminal **52(1)**.

FIG. 5 also includes additional subscriber-side fiber optic terminals **52** signified by the inclusion of subscriber-side fiber optic terminal **52(N)** to signify that “N” number of subscriber-side fiber optic terminals **52** can be provided, wherein “N” is any natural number. Multiple subscriber-side fiber optic terminals among subscriber-side fiber optic terminals **52(1)-52(N)** may be provided, wherein each subscriber-side fiber optic terminal **52** is connected to a different optical path among optical paths **108(1)-108(N)** in the network-side fiber optic terminal **102**. Some or all of the optical paths **108(1)-108(N)** may have optical splitters **111(1)-111(N)** to split optical signals from the network-side optical fibers **106**. In this regard, different network services can be provided to multiple subscriber-side fiber optic terminals **52(1)-52(N)**. The network services provided to the subscriber-side fiber optic terminals **52(1)-52(N)** are determined by the optical splitters **111(1)-111(N)** determining the optical paths **108(1)-108(N)** connected to the subscriber-side fiber optic terminals **52(1)-52(N)**. Thus, for example, if it is desired to provide different network services to subscribers located in close proximity, multiple subscriber-side fiber optic terminals **52(1)-52(N)** can be provided and co-located. Each subscriber-side fiber optic terminal **52(1)-52(N)** would provide one or more network services from the network-side fiber optic terminal **102**. Subscribers can be connected to the subscriber-side fiber optic terminals **52(1)-52(N)** based on the network service to be provided.

The choice between a centralized splitting model, such as for example provided in FIGS. 3 and 4, and a distributed splitting module, such as for example provided in FIG. 5, can be driven by splitting strategy, including subscriber density and anticipated future changes. A distributed splitting approach may work well in lower-density areas or places with space constraints that limit fiber optic cable sizes. A central-

12

ized splitting approach may provide less stranded ports, and efficiently utilize network electronics.

FIGS. 6 and 7 illustrate a schematic view of an example fiber optic terminal that may be provided as the fiber optic terminal **52** in FIGS. 3-5 and will be described below in this regard. However, note that the subscriber-side fiber optic terminal **52** illustrated in FIGS. 6 and 7 and the components provided therein may be provided in the network-side fiber optic terminal **102** in FIG. 5 as well. In this regard, the subscriber-side fiber optic terminal **52** illustrated in FIG. 6 comprises a base **122** and a terminal cover **124** hingedly affixed to the base **122** and opened thereon. The base **122** and the terminal cover **124** may be made of a rigid material, such as aluminum, plastic, or thermoplastic, as examples. The base **122** and the terminal cover **124** serve to close off and protect the internal components of the subscriber-side fiber optic terminal **52** when the terminal cover **124** is closed on the base **122**, as illustrated in FIG. 7.

With continuing reference to FIG. 6, the terminal cover **124** is generally rectangular in this embodiment, although other shapes are possible. The terminal cover **124** in this embodiment is hingedly affixed to the base **122** of similar form along an edge **125** of a right side wall **126** at one or more hinge locations **127** (see also, FIG. 7). In this manner, the terminal cover **124** can be rotated about the hinge locations **127** when the terminal cover **124** is opened from the base **122**. The base **122** is also comprised of a left side wall **128** disposed opposite and generally parallel to the right side wall **126**, both of which are attached or interconnected on ends to a top side wall **129** and bottom side wall **130** (see also, FIG. 7). The right side wall **126**, left side wall **128**, top side wall **129** and bottom side wall **130** are either attached as separate pieces, or portions bent upward from a single sheet of material in planes orthogonal or substantially orthogonal about a back wall **131**. In this manner, an interior chamber **132** is formed within the base **122**. The interior chamber **132** provides room for routing and/or storage of network-side and subscriber-side fiber optic cables **56, 60** and the network-side and subscriber-side optical fibers **54, 58** therein and making optical interconnections between the two, including through any intermediate optical components that may be provided in the subscriber-side fiber optic terminal **52**, as will be described below.

With continuing reference to FIGS. 6 and 7, a technician can open the terminal cover **124** to access the interior chamber **132** of the subscriber-side fiber optic terminal **52**, such as to install or reconfigure optical interconnections within the subscriber-side fiber optic terminal **52**. After completion, the terminal cover **124** can be closed against the base **122** to close the subscriber-side fiber optic terminal **52**, thus closing off access to the interior chamber **132**. When the terminal cover **124** is closed in this example, as illustrated in FIG. 7, the subscriber-side fiber optic terminal **52** has the approximate dimensions of four hundred thirty (430) millimeters (mm) height (H_1), four hundred (400) mm width (W_1), and one hundred thirty-five (135) mm depth (D_1). However, the subscriber-side fiber optic terminal **52** is not limited to these dimensions and any dimensions desired are possible.

As illustrated in FIG. 6 and discussed in more detail herein, the subscriber-side fiber optic terminal **52** and its internal components facilitate making optical connections between optical fiber(s) provided by one or more network-side fiber optic cables **56** and one or more subscriber-side fiber optic cables **60** to establish a connection between an end subscriber and a fiber optic network. Both the network-side fiber optic cable **56** and the subscriber-side fiber optic cable **60** may be distribution cables. In this regard, as illustrated by example in FIG. 6, the network-side fiber optic cable **56** provides the one

or more network-side optical fibers **54** configured to be optically connected to a fiber optic network for carrying optical signals to and from the fiber optic network. The subscriber-side fiber optic cable **60** also contains the subscriber-side optical fibers **58** which are configured to be run to or towards end subscribers directly or through one or more intermediate terminals and/or other optical components. Thus, when a network-side optical fiber(s) **54** provided in the network-side fiber optic cable **56** is optically connected to a subscriber-side optical fiber(s) **58** provided in the subscriber-side fiber optic cable **60** within the subscriber-side fiber optic terminal **52** as previously discussed, an optical connection can be established between a subscriber and a fiber optic network.

The one or more network-side optical fibers **54** from the network-side fiber optic cable **56** and the one or more subscriber-side optical fibers **58** from the subscriber-side fiber optic cable **60** are optically connected to each other at the fiber optic connection panel **66**. The fiber optic connection panel **66** can be a panel or module that contains or supports a plurality of optical fiber connections. As previously discussed, the fiber optic connection panel **66** support one or more input fiber optic adapters **68** and output fiber optic adapters **70** for supporting optical fiber connections. The input and output fiber optic adapters **68**, **70** support making optical connections between one or more network-side optical fibers **54** and the subscriber-side optical fibers **58**. The subscriber-side fiber optic terminal **52** illustrated in FIG. **6** contains the optical splitters **84**, **90** provided in the subscriber-side fiber optic terminal **52** illustrated in FIG. **6** and previously described. The remaining components illustrated in the subscriber-side fiber optic terminal **52** in FIG. **6** are the same components previously described above with regard to FIGS. **3** and **4** and thus will not be re-described here.

The network services that can be provided to subscribers include, but are not limited to, RfOG, ATM PON (APON), Broadband PON (BPON), EPON, GPON, 10 G-EPON, 10 G-GPON, and WDM-PON. The fiber optic terminals described herein can include, but are not limited to, LCPs and FDTs. For example, the fiber optic terminal as used herein can be a splice terminal, patch terminal or the like, or any combination thereof. If fiber optic connectors and/or adapters are provided in the fiber optic terminals, the fiber optic connectors and/or adapters may be for any type of optical connector, including but not limited to an LC, SC, MTP, FC, ST, MU, or MTRJ, without limitation. If optical splitters are provided in the fiber optic terminals, the optical splitters can be of any type or configuration, including without limitation, 1×2, 1×4, 1×8, 1×16, 1×32, 1×64, 1×128, and 2×2.

The fiber optic terminals disclosed herein may be used for any fiber optic distribution application, including but not limited to directly or intermediately routing fiber optic cables and optical fibers from a fiber optic network(s) to subscriber premises and end subscribers, including but not limited to various fiber-to-the-premises (FTTP), fiber-to-the-home (FTTH), fiber-to-the-business (FTTB), and other fiber initiatives (generally described as FTTx). Subscriber premises include, but are not limited to single-dwelling units (SDU), multi-dwelling units (MDU), businesses, and/or other facilities or buildings. The fiber optic terminals may be installed in any location, including an aerial location, buried, or disposed in a larger enclosure, such as a ground pedestal.

The network-side and subscriber-side fiber optic cables may be any type of fiber optic cable and include any type of optical fibers in any form. Further, as used herein, it is intended that terms “fiber optic cables” and/or “optical fibers” include all types of single mode and multi-mode light waveguides, including one or more optical fibers that may be

upcoated, colored, buffered, ribbonized and/or have other organizing or protective structure in a cable such as one or more tubes, strength members, jackets or the like. Likewise, other types of suitable optical fibers include bend-insensitive optical fibers, or any other expedient of a medium for transmitting light signals. An example of a bend-insensitive optical fiber is ClearCurve® Multimode fiber commercially available from Corning Incorporated.

Many modifications and other embodiments of the embodiments set forth herein will come to mind to one skilled in the art to which the embodiments pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. These modifications include, but are not limited to, the type or different network services provided or overlays of services, the type or number of fiber optic terminals, the type or number of optical fibers or fiber optic cables carrying optical fibers to and from fiber optic terminals, whether different network services are provided through connectors, connection panels, or optical splitters, and/or whether different network services are provided to subscribers in a centralized or distributed manner.

Therefore, it is to be understood that the description and claims are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. It is intended that the embodiments cover the modifications and variations of the embodiments provided they come within the scope of the appended claims and their equivalents. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

What is claimed is:

1. A fiber optic terminal, comprising:

a first optical path configurable to provide a first network service by providing one of a first network-side optical fiber and a second network-side optical fiber connected to one of a first subscriber-side optical fiber and a second subscriber-side optical fiber; and

a second optical path configurable to provide a second network service by providing one of the first network-side optical fiber and the second network-side optical fiber not provided in the first optical path, connected to one of the first subscriber-side optical fiber and the second subscriber-side optical fiber not provided in the first optical path,

wherein the first optical path is reversibly changeable between the first network-side optical fiber and the second network-side optical fiber, and is reversibly changeable between the first subscriber-side optical fiber and the second subscriber-side optical fiber, and

wherein the second optical path is reversibly changeable between the first network-side optical fiber and the second network-side optical fiber, and reversible changeable between the first subscriber-side optical fiber and the second subscriber-side optical fiber.

2. The fiber optic terminal of claim **1**, wherein the first optical path is reversibly changeable by changing at least one of the connections at the terminal of one of the first network-side optical fiber, the second network-side optical fiber, the first subscriber-side optical fiber, and the second subscriber-side optical fiber.

3. The fiber optic terminal of claim **1**, wherein the second optical path is reversibly changeable by changing at least one of the connections at the terminal of the other one of the first network-side optical fiber, the second network-side optical fiber, the first subscriber-side optical fiber and the second subscriber-side optical fiber.

4. The fiber optic terminal of claim 1, wherein the first optical path is not homogeneous with the second optical path.

5. The fiber optic terminal of claim 1, wherein the first optical path includes a first non-split fiber optic connection.

6. The fiber optic terminal of claim 1, wherein the second optical path includes a second non-split fiber optic connection.

7. The fiber optic terminal of claim 1, wherein the first optical path includes a first optical splitter.

8. The fiber optic terminal of claim 7, wherein the second optical path includes a second optical splitter.

9. The fiber optic terminal of claim 1, wherein the first network service is comprised of optical signals at a first wavelength in the first optical path overlaid on optical signals at a second wavelength different from the first wavelength in the first optical path.

10. The fiber optic terminal of claim 1, wherein at least one of the first optical path and the second optical path includes at least one fiber optic connector.

11. The fiber optic terminal of claim 10, further comprising at least one parking area configured to receive the at least one fiber optic connector when the at least one fiber optic connector is not connected to at least one of the first subscriber-side optical fiber and the second subscriber-side optical fiber.

12. The fiber optic terminal of claim 1, wherein the first network service is a service comprised from the group consisting of Asynchronous Transfer Mode (ATM) Passive Optical Network (PON) (APON), Broadband PON (BPON), Ethernet PON (EPON), Gigabit PON (GPON), ten (10) Gigabit EPON (10G-EPON), 10G-GPON, WDM-based network services, and Radio Frequency over Glass (RFoG).

* * * * *